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ABSTRACT

The instructional materials and classroom activities described in the document are intended to aid teachers in grades 10 through 12 develop and implement educational programs dealing with energy-related issues. The document is presented in four sections. Section I explains the organization of the document and summarizes how teachers should implement activities and assess student performance. Section II consists of a matrix of activities described in the document. Information is presented on grade level, time required, and subject matter. Section III describes learning activities in six areas: (1) sources of energy, (2) uses of energy, (3) conversion of energy from one form to another, (4) impact of energy use on the environment, (5) limits of the earth's resources, and (6) the future. For each activity, information is presented on title, concept, time, implementation, materials, and optional activities. Activities involve students in library research, identifying energy sources used in food and clothing production, suggesting solutions to energy use problems, responding orally and in writing to articles on energy costs and energy use, analyzing energy impact statements, identifying sources of unwise energy use, and discussing energy-related topics with classmates and resource people. The final chapter presents information on student assessment. Suggested test items are presented along with suggestions on how to use them and an explanation of the origin of the test items. (DB)

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ENERGY AND CONSERVATION EDUCATION

Activities for the Classroom

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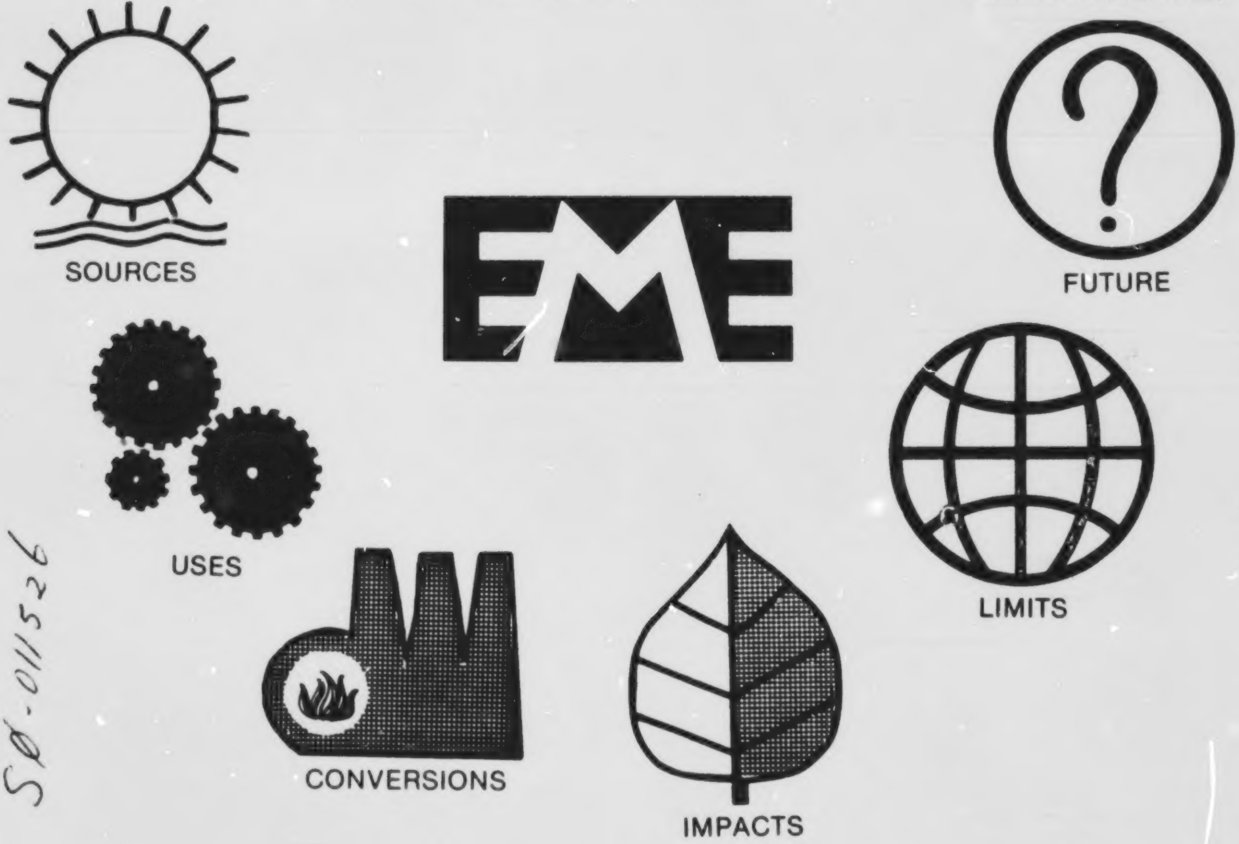
Grades 10-12



S0-011526

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CREDITS

The Learning Activity Packages are the result of a three-year development effort by Energy & Man's Environment and educational agencies in the Northwest. The development project was designed to produce practical and objective energy and conservation education classroom resources.

Phase I of the development process began in 1972, when educators and industry representatives met under the leadership of the Washington State Department of Public Instruction to establish a framework of goals and objectives essential to an understanding of energy and energy-related environmental issues. Six principal topic areas were identified: Sources of Energy, Uses of Energy, Conversion of Energy, Impacts of Energy, Limits of Energy and Future Sources of Energy. Each topic was described in the form of multidisciplinary goals, concepts and objectives. The framework was expanded into an Activity Guide and subjected to testing and revision. This Guide appeared at the beginning of the energy dilemma and served as a model for many subsequent efforts across the United States. Contributors to the first edition of the Guide were:

La Von Bucher, Teacher
Dick Downie, Engineer
Dan Horn; Professor, Earth Science
David Kennedy; Administrator, Environmental Education
Joyce Lekas, Teacher
Don Orlich; Professor, Education
Thomas Ris, Communications
Elaine Smith, Teacher
Loretta Smithburg, Teacher
Dave Stronck; Professor, Education/Biology
Lyle Wilhelmi; Administrator Science

The second phase of the instructional materials development began in 1973. With the assistance of state departments of education, EME selected and contracted with six outstanding school districts to develop teacher-made instructional materials based on the Activity Guide framework. The districts selected were Cheyenne, Wyoming; Everett and Olympia, Washington; and Beaverton, Eugene and Medford, Oregon. Key Area Resource Persons in Phase II were Bob Larson, Larry Torgerson, Floyd Smith, Lois Helton, and Lyle Wilhelmi. Phase II continued for nine months and produced a wide range of multidisciplinary, 1-12 instructional resources.

In September, 1974, Phase III of the curriculum writing effort began with the awarding of a substantial contract to the Beaverton, Oregon School District. Under the direction of Lois Helton, a team of master teacher writers scrutinized, refined and rewrote the materials produced in Phase II. The team was composed of Dan Grimes, Mabel Lund, Shirley Barnes, and Ted Parker. Essential to the success of this effort were Dalton Plunkett and Harold Wik, who provided leadership and facilitated the development process. Chloe Poole and Omer Gosnell added their creative skills to design and illustration.

Concurrent with the initiation of Phase III, a skilled group of writers from business, industry, government and the private sector came together to revise and strengthen the Activity Guide. Utilizing several hundred evaluations from teacher users, the writers refined the conceptual framework, expanded the resource material and created a new organizational structure. The result was a set of seven Activity Guides described by one leading curriculum administrator as "the single richest source of energy and conservation education teaching ideas available anywhere." The new material was used by Phase III writers and keyed to the expanded framework of topics, concepts, and instructional objectives. Authors of the new Activity Guide were:

La Von Bucher, Teacher
George Carter, Energy Information
Don Charnley; Attorney, Legislator
Ed Dalton, Teacher
Roberta Davis, Parent
Dick Downie, Engineer
Lois Helton, Teacher
Dan Horn; Professor, Earth Science
Bob Keesey, Economist
Dave Kennedy; Administrator, Environmental Education
Al Krieg, Engineer
Ron Lamb; Professor, Biology
Keith Loeffler, Energy Information
Jack Vogel, Energy Information
Harold Wik; Administrator, Curriculum
Lyle Wilhelmi; Administrator, Curriculum
Warren Wolf, Art School Director

In 1975, Learning Activity Packages from Phase III were placed in Beaverton, Oregon and Everett, Washington schools and subjected to vigorous classroom evaluation. External, third-party assessment was instrumented and supervised by Dr. Quentin Clarkson of Portland State University. Supervision at the school district level was managed by Wayne Neuberger, Evaluation Specialist for the Beaverton School District, and Jim Pringle in the Everett, Washington School District. Teacher evaluators in the Beaverton and Everett School Districts included:

Jim Pringle	Cascade High School
Marlene Lindstrand	Cascade High School
Dave Dailey	Cascade High School
Elliot Cheap	Cascade High School
Tony Jongejan	Everett High School
Shirley Barnes	West Tualatin View Elementary
Cindy Claridge	Beaverton School District #48
Jackie Fitzgerald	William Walker Elementary
Maria Gander	West Tualatin View Elementary
Dan Grimes	William Walker Elementary
Lois Helton	Five Oaks Middle School
Pat Kingman	Aloha Park Elementary
Mabel Lund	Mountain View Middle School
Rowena Marks	West Tualatin View Elementary
Jim Miller	Aloha High School
Shari Noldge	William Walker Elementary
Court Ofelt	Mountain View Middle School
Ted Parker	Aloha High School
Joanne Profitt	Five Oaks Junior High School
Kathy Vassias	Beaverton School District #48
Bruce Weitzel	Five Oaks Middle School
John West	Five Oaks Middle School

The final step in development, Phase IV, began in September, 1976. Under the direction of Dan Grimes, EME Oregon Coordinator, and Duane Altig, Parkrose School District, each Learning Activity Package was examined and revised based upon the field test evaluation. Production assistance was provided by Darlene McLaughlin, Sharon Scherner, and Jane Aldrich.

Many persons not specifically named here contributed personally to the success of this major undertaking. Among those not already mentioned were Helen White, Diane Nelson, Luanne Campbell, Marcia Whitelock, Doris Graffam, and Roberta Davis. To those teachers, students, curriculum specialists and parents who remain unnamed but gave so freely of their time and skill, we extend our sincere and grateful appreciation. We hope our effort will materially benefit our teaching colleagues.

John Jones, D.Ed.
President
Energy & Man's Environment
Portland, Oregon

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  1. Sources
  2. Uses
  3. Conversions
  4. Impacts
  5. Limits
  6. Future

III. LEARNING ACTIVITIES

Section One — Sources

Goal:

It is essential that each person know that there are many sources of energy.

Section Two — Uses

Goal:

It is essential that each person know that people are dependent upon energy.

Section Three — Conversion

Goal:

It is essential that each person know that energy can be converted from one form to another.

Section Four — Impacts

Goal:

It is essential that each person know how humankind's use of energy creates an impact on the environmental and economic systems.

Section Five — Limits

Goal:

It is essential that each person know that the earth's resources are limited.

Section Six — Future

Goal:

It is essential that each person know that new energy sources and more efficient systems, accompanied by different consumption practices, may alter the world energy dilemma.

IV. STUDENT ASSESSMENT
  A. Using The Suggested Test Items
  B. Origin Of Test Items
  C. Types Of Suggested Test Items
  D. Sample Test Items

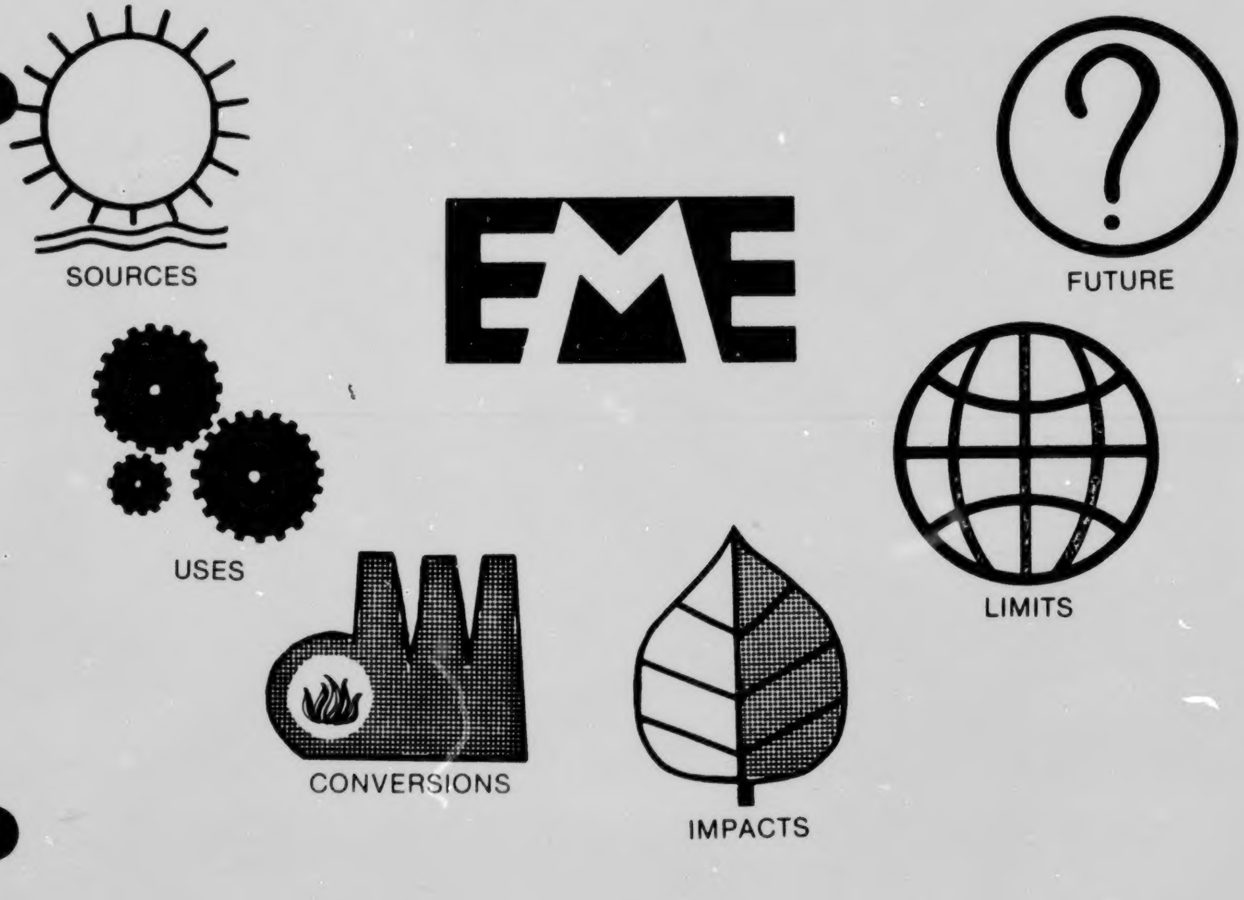
SOURCES
USES
CONVERSION
IMPACTS
LIMITS
FUTURE
ASSESSMENT

IMPLEMENTATION HANDBOOK

ENERGY AND CONSERVATION EDUCATION

Activities for the Classroom

Grades 10-12



ACTIVITY NOTEBOOK
IMPLEMENTATION HANDBOOK

Overview

Energy & Man's Environment (EME) is a unique educational program developed to prepare instructional materials dealing with energy education--primary grades through high school. EME was initiated in 1972 by the Public Power Council of the Northwest Public Power Association in cooperation with leading educators in the region. In 1973, members of the Northwest Electric Light & Power Association (NELPA) joined the program. In 1976, additional business, governmental and educational agencies joined the Northwest consortium to strengthen EME efforts. The precedent of cooperative effort has resulted in an educator-directed, non-profit corporation supported by resources from business, government, education, and the private sector. The program has one goal--to make the subject of energy understandable both to the educator and the student. EME's primary concern is to present energy-related issues from all points of view accurately and objectively. EME offers conferences, workshops, seminars, speakers, and special programs to meet the energy-related needs of educators. Each activity can be "custom tailored" to meet the specific needs and interest of the participants.

The educational materials presented in the EME Activity Notebooks 1-12 are an example of the teacher-prepared materials offered by EME for use by classroom teachers in presenting energy-related issues.

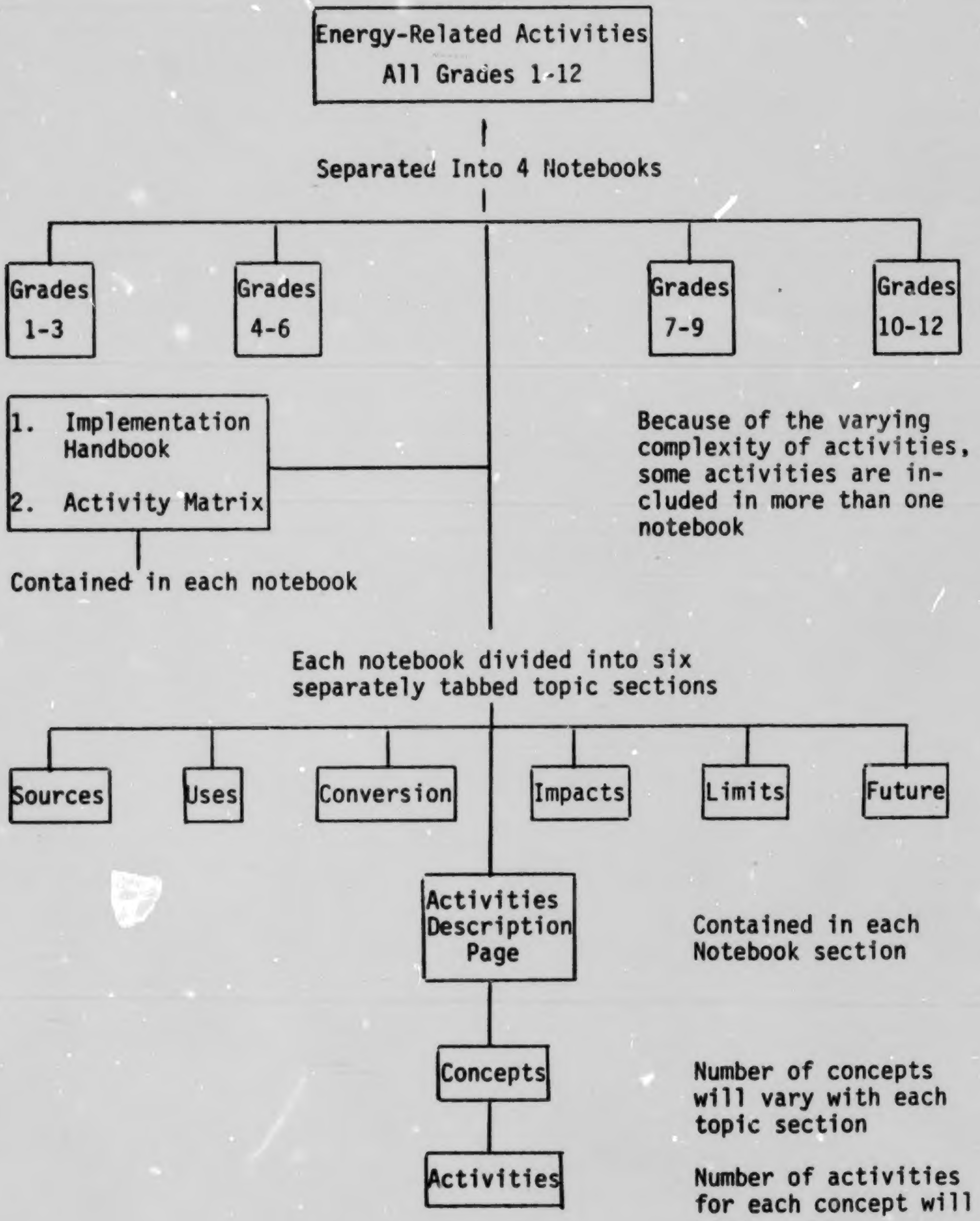
Organization

There are four notebooks covering all grade levels 1-12. The arrangement of the notebooks are (1-3), (4-6), (7-9), (10-12). Because of the varying complexity and multidisciplinary nature of the activities, each notebook includes an implementation handbook and an activities matrix which identifies topics, activities, grade levels, subject matter areas, etc. for quick reference by the teacher. The individual notebooks contain activity description pages for each of the six topics in the notebook.

The six principal sections or topics in each notebook are: Sources of Energy, Uses of Energy, Conversion of Energy, Impacts of Energy, Limits of Energy, and Future Sources of Energy. Each topic contains a number of concepts which are necessary to a fundamental understanding of the general topic area. Listed under each concept are simply stated objectives or activities which are multidisciplinary in nature and vary in their complexity. Included within each of the activities is a complete breakdown as to the time needed for implementation of the materials, implementation procedures, assessment procedures, a suggested career education activity, and other information necessary for successful classroom use of the activities.

The following diagram will help to explain the notebook organization. The concepts which provide an overall guide to the intent of the main topic are within the description pages of the notebook. The activity objectives indicate the expected level of outcome from the materials to be presented in the classroom. Each activity is the "hands-on" experience which the student will accomplish to meet the expected outcome.

EME ACTIVITY NOTEBOOK ORGANIZATION


Energy-Related Activities
All Grades 1-12
Separated Into 4 Notebooks
Grades 1-3
Grades 4-6
Grades 7-9
Grades 10-12
1. Implementation Handbook
2. Activity Matrix
Each notebook divided into six separately tabbed topic sections
Sources
Uses
Conversion
Impacts
Limits
Future
Activities Description Page
Concepts
Activities

Contained in each notebook

Because of the varying complexity of activities, some activities are included in more than one notebook

Contained in each Notebook section

Number of concepts will vary with each topic section

Number of activities for each concept will vary

Contained in each notebook section

Teacher Implementation

The materials are designed to be used by classroom teachers in all grade levels. It is hoped that the instructors will feel free to alter, adapt, or change the activities to meet their own particular classroom needs and the needs of their students.

Some of the skills and concepts in the activities should be presented more than once to any given group of students. Therefore, in some instances, it may be desirable to repeat the activity at another grade level--either in its original or in an altered form.

Most of the activities require the students to be actively involved, both with other students and in actual use of the materials. This may require some adjustment of the traditional classroom situation.

There are many activities which contain handouts that can be duplicated for student use.

The actual use of the notebooks is relatively simple. Steps to locating a suitable activity are:

1. Select appropriate notebook.
2. Read activities matrix to select an activity title and number which most closely matches your interest, grade level, and subject matter.
3. Turn to the topic section of the notebook indicated by the activities matrix.
4. Read the description of the activity you selected, and then turn to the activity number in the notebook.
5. Read the activity.
6. Complete the activity. (Repeat these steps for additional activities.)

ASSIGNMENT FOR TODAY....

Assessment

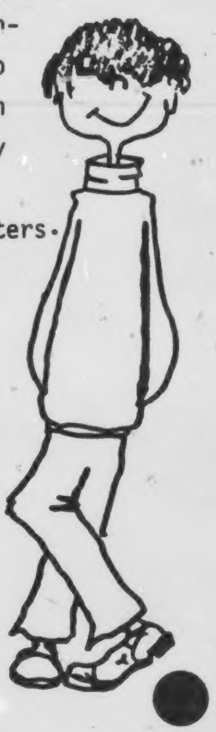
Included in each notebook are a series of sample test items for the teacher who wishes to pinpoint areas of weakness and strength in the individual student's knowledge of energy topics.

The test items are written so as to be easily understood by a majority of students. The sample questions are not definitive items and are not intended to be the final word on the materials in the notebook. Each of the activities has its own assessment procedures and these should also be utilized by the instructor. The test items may be used as an indicator of the general skill and knowledge level of students prior to the implementation of EME Lesson Plan Notebooks, or as a check on the retention level of students who have been presented materials from the EME Lesson Plan Notebooks. It is recommended that the teacher remain the ultimate judge as to the effectiveness of the activities as they are presented to the students, either in their original or instructor-altered form.

Follow-Up

The materials contained in the notebooks are continually undergoing extensive field testing and revisions to obtain the best possible materials to present to students. In the event that you, as a classroom teacher, wish to contribute more to the program of energy education, EME would be happy to hear from you. If you have any suggestions which could improve any phase of the organization, activities, etc., please contact EME headquarters.

Duane K. Altig



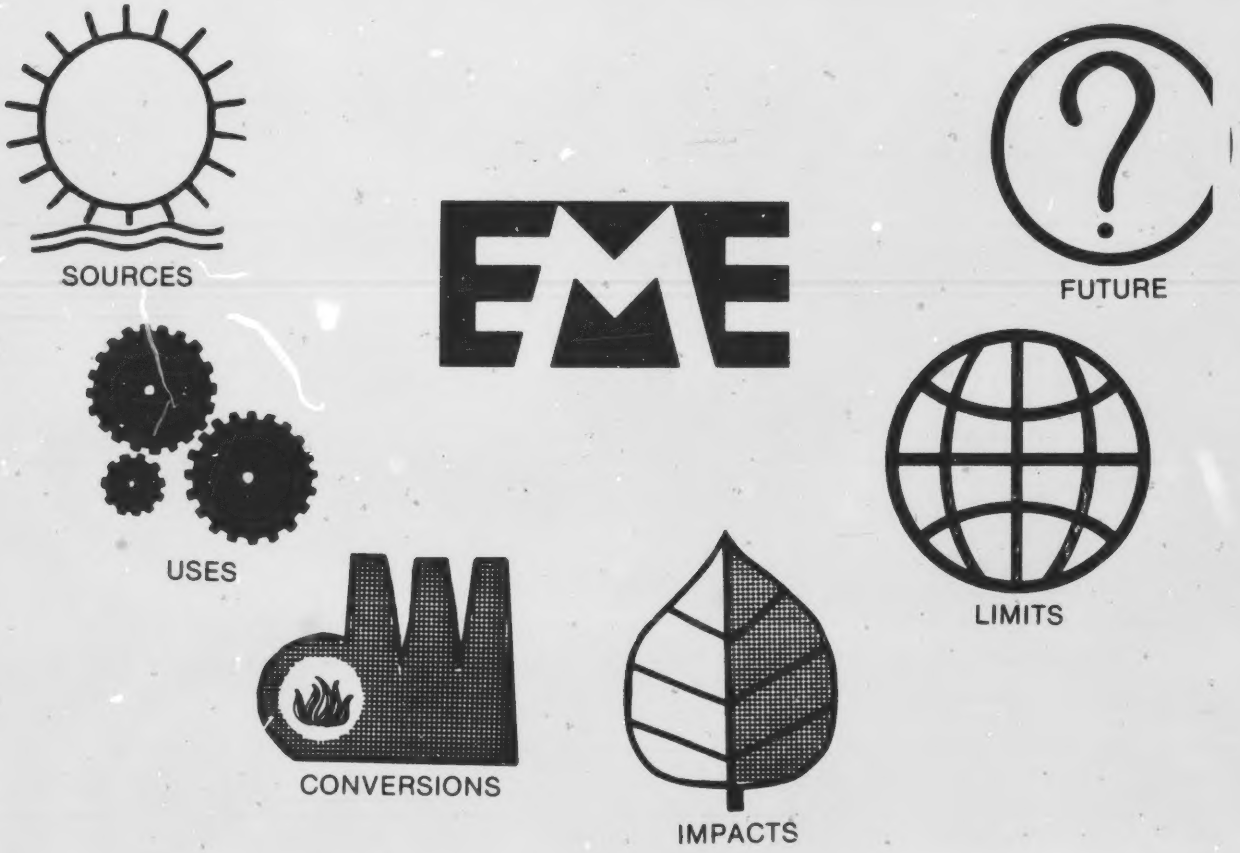
WARNING: SOME OF THE ACTIVITIES IN THIS NOTEBOOK ARE POTENTIALLY HAZARDOUS, DUE TO THE USE OF FLAMMABLE SUBSTANCES AND/OR HEAT. PLEASE EXERCISE EXTREME CAUTION. CHECK YOUR LOCAL AND STATE LAWS GOVERNING THE USE OF FLAMMABLE MATERIALS IN THE CLASSROOM.

ACTIVITY/SUBJECT MATTER MATRIX

ENERGY AND CONSERVATION EDUCATION

Activities for the Classroom

Grades 10-12



INDEX
ACTIVITY/SUBJECT MATTER MATRIX
SOURCES (10-12)

Activity #	Activity Title	Grade Level	Time In 45 Min. Class Prds.	SUBJECT MATTER AREAS										
				Math	Science	Soc.Sci.	Language Arts	Speech	Industr. Arts	Home Ec.	Consumer Ed.	Career Ed.	Health	Art
1	"Energy Used In Providing Food"	10-12	2-3		X	X				X		X		
2	"Energy Used In Providing Shelter"	10-12	Var.		X	X	X					X		
3	"Energy Costs"	10-12	2-3		X	X						X		
4	"Home Energy Sources"	10-12	Var.	X	X	X	X	X	X	X	X	X	X	X
5	"Conflicts"	10-12	4-5	X	X	X	X	X	X	X	X	X	X	X
6	"Energy Occupations"	10-12	3-4	X	X	X	X	X	X	X	X	X	X	X
7	"Energy Used In Providing Clothing"	9-10	3-4			X	X							X

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ACTIVITY/SUBJECT MATTER MATRIX
USES (10-12)

Activity #		Grade Level	Time In 45 min per.	SUBJECT MATTER AREAS										
				Math	Science	Soc.Sci.	Language Arts	Speech	Industr. Arts	Home Ec.	Consumer Ed.	Career Ed.	Health	Art
1	"Population vs. Food: An Energy Problem"	10-12	4-5		X	X						X	X	
2	"Water As An Energy Source"	10-12	Var.		X							X		
3	"Water--Under The Bridge Or Over The Dam"	10-12	2	X								X		
4	"Beauty-N-Energy"	10-12	Var.	X	X	X	X	X	X	X	X	X	X	X
5	"High Energy User vs. Conserver"	10-12	5-6		X	X	X					X		
6	"Space Heating: What's Best?"	10-12	Var.	X	X	X	X	X	X	X	X	X	X	X
7	"Energy Costs In Pollution Reduction"	10-12	1-3	X	X	X	X	X	X	X	X	X	X	X

Var. = Variable

INDEX
ACTIVITY/SUBJECT MATTER MATRIX
USES (10-12) (continued)

Activity #	Activity Title	Grade Level	Time In 45 min per.	SUBJECT MATTER AREAS										
				Math	Science	Soc.Sci.	Language Arts	Speech	Industr. Arts	Home Ec.	Consumer Ed.	Career Ed.	Health	Art
8	"Patterns Of Energy Use"	10-12	Var.	X	X	X	X	X	X	X	X	X	X	X
9	"Understanding Graphs Of Energy Use Related To Food Production"	10-12	1-2			X	X					X		
10	"The Costs Of Reducing Energy Consumption"	10-12	2-3		X	X						X		
11	"Things I Like To Do"	10-12	1			X						X		
12	"Leisure Time Activities"	10-12	1-2			X						X		

Var. = Variable

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ACTIVITY/SUBJECT MATTER MATRIX
CONVERSION (10-12)

Activity #	Activity Title	Grade Level	Time In 45 Min. Class Prds.	SUBJECT MATTER AREAS										
				Math	Science	Soc.Sci.	Language Arts	Speech	Industr. Arts	Home Ec.	Consumer Ed.	Career Ed.	Health	Art
1	"Trends In Nature"	10-12	Var.		X							X		
2	"Mouse Study"	10-12	Var.		X							X		
3	"Accommodation Of Waste Products"	10-12	Var.			X	X					X		
4	"Heat Conversion And Transfer"	10-12	1-2		X							X		
5	"Efficiency And Energy Conversion"	10-12	1-2	X	X							X		
6	"A New Law?"	10-12	Var.			X						X		
7	"Benefits or Problems of Conversion Technology"	10-12	3-4	X	X	X	X	X	X	X	X	X	X	X

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ACTIVITY/SUBJECT MATTER MATRIX
CONVERSION (10-12) (continued)

Activity #	Activity Title	Grade Level	Time In 45 Min. Class Prds.	SUBJECT MATTER AREAS										
				Math	Science	Soc.Sci.	Language Arts	Speech	Industr. Arts	Home Ec.	Consumer Ed.	Career Ed.	Health	Art
8	"Technology and Transportation"	10-12	4-5			X						X		

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ACTIVITY/SUBJECT MATTER MATRIX
IMPACTS (10-12)

Activity #	Activity Title	Grade Level	Time In 45 Min. Class Prds.	SUBJECT MATTER AREAS										
				Math	Science	Soc.Sci.	Language Arts	Speech	Industr. Arts	Home Ec.	Consumer Ed.	Career Ed.	Health	Art
1	"Predicting Environmental Impact"	11-12	3-4	X	X	X	X	X	X	X	X	X	X	X
2	"What Type of Shopping Area?"	10-12	Var.	X	X	X	X	X	X	X	X	X	X	X
3	"At Home With A Power Plant"	10-12	Var.			X	X					X		
4	"Environmental Impacts of Transportation"	10-12	Var.	X	X	X	X	X	X	X	X	X	X	X
5	"Lifestyle Choices and Energy Use"	9-10	3	X	X	X	X	X	X	X	X	X	X	X
6	"'Unwise' Energy Use"	9-10	4-5			X	X	X				X		
7	"Future Nuclear Plant Sites"	8-10	3-4	X	X	X	X	X	X	X	X	X	X	X

INDEX
ACTIVITY/SUBJECT MATTER MATRIX

IMPACTS (10-12) (continued)

Activity #	Activity Title	Grade Level	Time In 45 Min. Class Prds.	SUBJECT MATTER AREAS										
				Math	Science	Soc.Sci.	Language Arts	Speech	Industr. Arts	Home Ec.	Consumer Ed.	Career Ed.	Health	Art
8	"Freedom Of Choice vs. Energy Conservation Programs"	10-12	2-3			X	X					X		
9	"Site Review"	10-12	Var.	X	X	X	X	X	X	X	X	X	X	X
10	"The Alaska Pipeline: An Energy Dilemma"	10-12	3-5	X	X	X	X	X	X	X	X	X	X	X
11	"Traditional Values And Energy-Use Problem Solving"	10-12	3-4			X	X					X		
12	"Special Interest Groups"	10-11	Var.			X	X					X		
13	"Pros And Cons Of Energy Use"	10-12	3-4			X	X					X		
14	"Creative Descriptions Of Natural Pollutants or Contaminants"	10-12	Var.	X	X	X	X	X	X	X	X	X	X	X

Var.=Variable

INDEX
ACTIVITY/SUBJECT MATTER MATRIX
IMPACTS (10-12) (continued)

Activity #	Activity Title	Grade Level	Time In 45 Min. Class Prds.	SUBJECT MATTER AREAS										
				Math	Science	Soc.Sci.	Language Arts	Speech	Industr. Arts	Home Ec.	Consumer Ed.	Career Ed.	Health	Art
15	"A Week Of Garbage"	10-12	2-3	X	X	X						X		
16	"Careers In Environmental Science"	10-12	Var.	X	X	X	X	X	X	X	X	X	X	X

Var.=Variable

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ACTIVITY/SUBJECT MATTER MATRIX
LIMITS (10-12)

Activity #	Activity Title	Grade Level	Time In 45 Min. Class Prds.	SUBJECT MATTER AREAS										
				Math	Science	Soc.Sci.	Language Arts	Speech	Industr. Arts	Home Ec.	Consumer Ed.	Career Ed.	Health	Art
1	"Oil: A Finite Resource"	10-12	2-3	X								X		
2	"Consumption Of A Finite Resource"	11-12	4-5	X		X					X	X		
3	"Conserving Natural Resources"	10-12	3-4			X					X	X		
4	"Limit?"	10-12	1	X	X	X	X	X	X	X	X	X	X	X
5	"Energy Demands And Fossil Fuels"	10-12	1-2	X	X	X						X		
6	"Energy For Energy"	10-12	Var.	X	X	X	X	X	X	X	X	X	X	X

Var.= Variable

INDEX
ACTIVITY/SUBJECT MATTER MATRIX
LIMITS (10-12) (continued)

Activity #	Activity Title	Grade Level	Time In 45 Min. Class Prds.	SUBJECT MATTER AREAS											
				Math	Science	Soc.Sci.	Language Arts	Speech	Industr. Arts	Home Ec.	Consumer Ed.	Career Ed.	Health	Art	
7	"Solutions To The Utilities' Economic Problems"	10-12	1-5	X	X	X	X	X	X	X	X	X	X	X	
8	"Energy Sources: Future And Past Adequacy"	10-12	3-4			X						X			

INDEX
ACTIVITY/SUBJECT MATTER MATRIX
FUTURE (10-12)

Activity #	Activity Title	Grade Level	Time In 45 Min. Class Prds.	SUBJECT MATTER AREAS											
				Math	Science	Soc.Sci.	Language Arts	Speech	Industr. Arts	Home Ec.	Consumer Ed.	Career Ed.	Health	Art	Environ. Studies
1	"Geothermal Energy: Dilemmas and Problems"	10-12	2	X	X	X	X	X	X	X	X	X	X	X	X
2	"Analyzing Facts About Fusion"	11-12	1-2		X	X	X					X			
3	"What's In The Written Word About Energy?"	10-12	2		X	X						X			X
4	"The Potential Of Geothermal Energy"	11-12	2		X	X	X					X			
5	"Solar Energy Collection And Production"	10-12	1	X	X	X	X	X	X	X	X	X	X	X	X
6	"Nuclear Plant Locations"	10-12	1	X	X	X	X	X	X	X	X	X	X	X	X
7	"Nuclear Fusion Vocabulary"	11-12	1-2		X							X			

INDEX
ACTIVITY/SUBJECT MATTER MATRIX
FUTURE (10-12) (continued)

Activity #	Activity Title	Grade Level	Time In 45 Min. Class Prds.	SUBJECT MATTER AREAS								
				Math	Science	Soc.Sci.	Language Arts	Speech	Industr. Arts	Home Ec.	Consumer Ed.	Career Ed.
8	"Trade-Offs In Population Growth And Energy Use"	10-12	4	X	X	X						X
9	"Energy And The Economy"	10-12	Var.	X		X					X	X
10	"The Energy Intensive Society-What It Is Not"	10-12	4			X	X					X
11	"Decisions - Decisions"	10-12	Var.			X						X

SOURCES OF ENERGY

GOAL:

IT IS ESSENTIAL THAT EACH PERSON KNOW THAT THERE ARE MANY SOURCES OF ENERGY.

ACTIVITY
DESCRIPTION PAGE
SOURCES (10-12)

Goal:	It is essential that each person know that there are many sources of energy.
Concept:	Energy is the capacity to do work and is subject to natural laws.
Activity #1	"Energy Used In Providing Food" Grade level 10-12 Home Economics, Social Science, Science Given the opportunity to list common foods, the student will be able to identify the sources of energy used in providing food.
Concept:	High grade (concentrated) energy sources occur in relatively small amounts, and take relatively smaller amounts of "outside" energy to find and recover.
Activity #2	"Energy Used In Providing Shelter" Grade level 10-12 Social Science, Language Arts, Science Given the opportunity to list materials used in home construction, the student will be able to identify the sources of energy used in providing shelter and identify means to conserve these energy sources.
Activity #3	"Energy Costs" Grade level 10-12 Social Science, Science Given the opportunity to participate in a classroom discussion, the student will be able to describe the factors that cause an energy source or conversion to be expensive, and the factors that ultimately lower the cost.
Concept:	Access to energy sources affects the growth of differing technological, social, governmental, economic and cultural systems.
Activity #4	"Home Energy Sources" Grade level 10-12 All Subject Matter Areas Given the opportunity to complete the necessary research, the student will be able to determine a possible alternate energy source for his/her dwelling, its technological differences, costs, and installation possibilities.

ACTIVITY
DESCRIPTION PAGE
SOURCES (10-12) (cont.)

Activity #5
"Conflicts"
Grade level 10-12
All Subject Matter Areas

Given the opportunity to discuss conflicts related to our uses and sources of energy and resources, the student will be able to understand that changes in cultural patterns may result from our solutions to resource and energy use conflicts.

Concept: Exploitation of different energy sources results in a variety of occupations.

Activity #6
"Energy Occupations"
Grade level 10-12
All Subject Matter Areas

Given the opportunity to select an energy source, the student will be able to list energy related occupations and write descriptive paragraphs of training needed for those occupations.

Activity #7
"Energy Used In Providing Clothing"
Grade level 9-10
Social Science, Career Education, Language Arts

Given the opportunity to list articles of clothing, the student will be able to identify the sources of energy used in providing clothing.

title: "Energy Used In Providing Food"

sources

concept: Energy is the capacity to do work and is subject to natural laws.

objective: Given the opportunity to list common foods, the student will be able to identify the sources of energy used in providing food.

time: 2-3 45 minute class periods

subject matter area: Home Economics, Science, Social Science

grade: 10-12

activity no. 1

implementation:

Activity:

1. List all the different foods including snacks, drinks, etc., consumed in two average days.
2. Under each food, list the sources of energy required in producing it. In some instances this will necessitate also listing the products involved in the preparation of the food, i.e., flour, yeast, shortening, sugar, etc. List the source of energy by each item. State whether the sources are renewable or nonrenewable.
3. Considerable energy was drawn from sources in making it possible for the food to be prepared. Machines, equipment, transportation, processing plants, etc., are all involved in processing the food you consume. List as many of these as you can. Identify the sources of the energy they required. State whether the sources are renewable or nonrenewable.
   a. You can conclude from your research that there is an extreme drain on energy sources in supplying our nation with food.

materials:

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implementation:

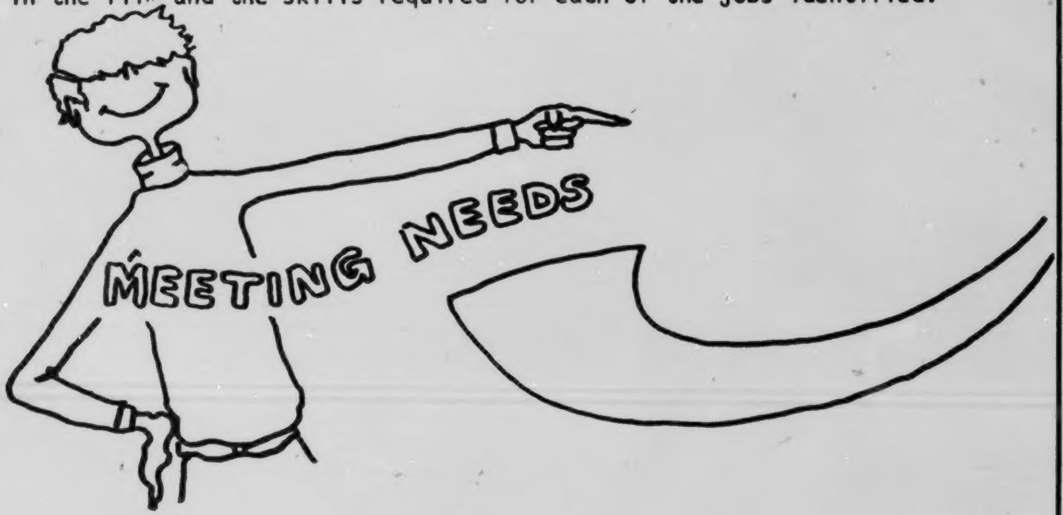
Activities: (continued)

4. Write as many suggestions as you can for conserving energy demands, yet meeting needs adequately. (Please note the word adequately does not mean an unnecessary surplus or a luxury standard.)

5. Choose a different but comparable set of initial objects for the investigation.

SUGGESTED CAREER EDUCATION ACTIVITY:

Given the opportunity to view a film on the manufacturing process of an individual food item, the student will be able to identify the job shown in the film and the skills required for each of the jobs identified.



materials:

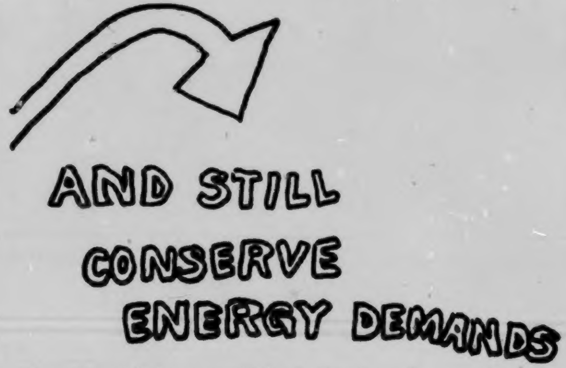
SUGGESTED ASSESSMENT PROCEDURE:

Ask the student to:

Enumerate sources of energy used in providing daily essential needs.

Suggest means to conserve those sources in relation to meeting the daily essential needs.

Given the opportunity to identify and list the sources of energy used in providing daily essential needs, the student will be able to suggest means to conserve the sources of energy.



Developed by: Mabel M. Lund
Beaverton School District
Beaverton, OR

title: "Energy Used In Providing Shelter"

sources

concept: High grade (concentrated) energy sources occur in relatively small amounts and take relatively smaller amounts of "outside" energy to find and recover.

objective: Given the opportunity to list the materials used in home construction, the student will be able to identify the sources of energy used in providing shelter, and identify means to conserve these energy sources.

time: Variable

subject matter area: Social Studies, Science
Language Arts

grade: 10-12

implementation:

Activity:

1. This activity may be done individually or in small groups.
2. Visit a new house that is for sale observing carefully the inside and the outside. Make a list of as many materials as you can that were utilized in the construction of the home.
3. Take the list and item by item enumerate all the steps through which each material was processed in becoming the final product. Also, list the steps involved in transporting the products to their destination. With each item, state the source or sources of the energy utilized. State whether it is renewable or nonrenewable.
4. Now review your entire investigation. List any suggestions you have for providing adequate shelter for our nation while at the same time reducing the use of energy sources.

materials:

TAKE TIME FOR RESEARCH!

activity no. 2

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implementation:

SUGGESTED CAREER EDUCATION ACTIVITY:

Given the opportunity to complete the activity "Energy used in providing shelter," the student will be able to list ten occupations of interest to research in the Dictionary of Occupational Titles and the Occupational Outlook Handbook.

materials:

SUGGESTED ASSESSMENT PROCEDURE:

Given the opportunity to build an energy ladder for the materials used in the construction of a new home, the student will be able to enumerate the sources of energy used, and the means to conserve the energy sources in relation to meeting the daily essential needs.

Developed by:	Mabel M. Lund Beaverton School District Beaverton, OR
Revised by:	Duane K. Altig

title: "Energy Costs"

sources

concept: High grade (concentrated) energy sources occur in relatively small amounts, and take relatively smaller amounts of "outside" energy to find and recover.

objective: Given the opportunity to participate in a classroom discussion, the student will be able to describe the factors that cause an energy source or conversion to be expensive and the factors that ultimately lower the costs.

time: 2-3 45 minute class periods

subject matter area: Social Science, Science

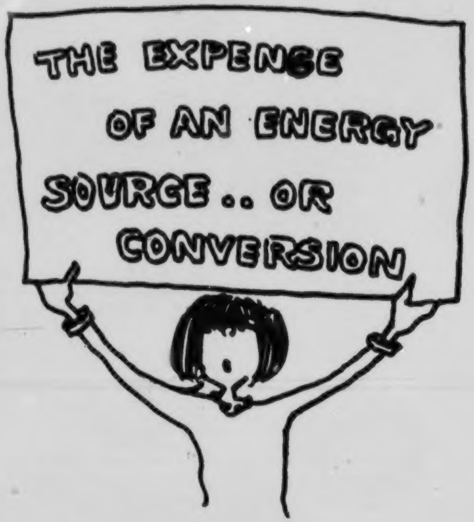
grade: 10-12

implementation:

Activity:

1. "What makes the initial cost of an energy source or energy conversion method so expensive?" Have the students brainstorm a list of factors. Either as groups or individuals, pick out an energy source (water, coal, solar, oil, garbage, oil shale, other) and describe the factors that elevate costs of initial development.
2. Factors:
   - a. Technological developments
   - b. Cost at site vs. cost at usage point (transportation or transmission).
   - c. Increased use of source.
   - d. Technical, lower costs.
     - Oil: exploration, drilling, pipelines, refining.
     - Electricity: generation, transmission, distribution.
     - Coal: mining, transportation, coal trains.
   - e. Capital outlay, e.g., $5.00 invested for $1.00 electric power revenue.
   - f. Interest rates.
   - g. Environmental costs (pollution, land use, etc.)
   - h. Competition with other sources.

materials:



activity no. 3

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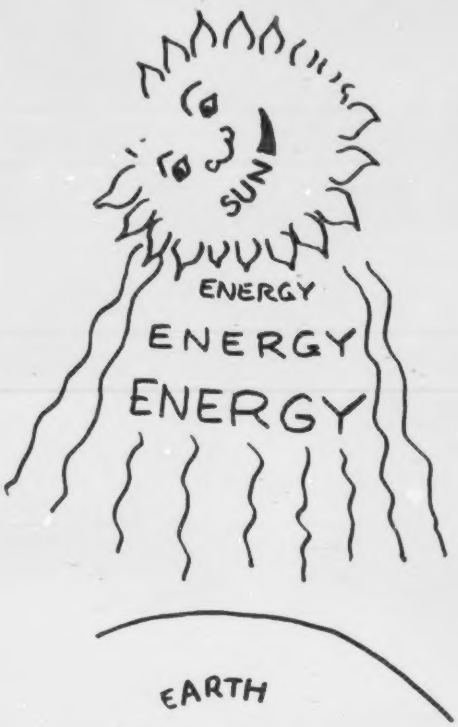
implementation:

SUGGESTED CAREER EDUCATION ACTIVITY:

the economic and noneconomic benefits of the occupation of the person being interviewed.



materials:

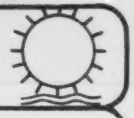
SUGGESTED ASSESSMENT PROCEDURE:

Given the opportunity to participate in a class room discussion on the question, "What makes the initial cost of an energy source or energy conversion method so expensive?" the student will be able to describe, either as an individual or as member of a group, three factors that cause an energy source or conversion to be expensive, and three factors that will lower the costs.

Developed by: Ted Parker
Beaverton School District
Beaverton, OR

title: "Home Energy Sources"

sources



concept: Access to energy sources affects the growth of differing technological, social, governmental, economic and cultural systems.

objective: Given the opportunity to complete the necessary research, the student will be able to determine a possible alternate energy source for his/her dwelling, its technological differences, costs, and installation possibilities.

time: Variable: Dependent upon the depth desired by the instructor.

subject matter area: All

grade: 10-12

implementation:

Activity:

1. Introduction: After many complaints about high energy costs, you are given the task of finding an alternate lower cost energy source.
2. List possible alternate energy sources.
3. Each student will choose one energy source and:
    - a. Describe type of installation possible where you live.
    - b. Sketch or diagram the installation.
    - c. Determine the amount of energy you would receive from the source.
    - d. Calculate what it will cost to install the energy source.
    - e. Determine when the cost of installation and operation would be paid for, considering increasing fuel bills.
4. Would you have the energy source installed where you live? Support your answer.
    - a. Discussion may vary in depth and length depending upon students' backgrounds and understanding of energy sources.

materials:

Consult back issues of Popular Science, Mother Earth News, etc. for articles on alternative sources of energy.

Films:

"Backyard Alternative Energy"
Kirby Brumfield Energy Productions
10003 S.W. 60th
Portland, OR 97219
(503) 246-7072
$295 (subject to change)

"Energy: New Sources"
Churchill Films
662 N. Robertson Blvd.
Los Angeles, CA 90069
213-657-5110

activity no. 4

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implementation:

SUGGESTED CAREER EDUCATION ACTIVITY:

Given the opportunity to discuss in class the implications changes in energy use may have on society, the student will be able to identify possible economic problems which might result for the laborer in American society.

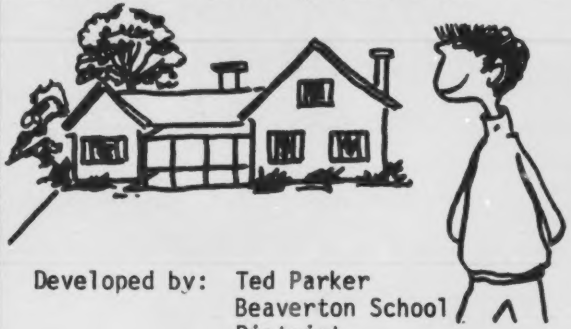
CHANGE THE ENERGY SOURCE — FIND COST OF CHANGE

materials:

SUGGESTED ASSESSMENT PROCEDURE:

Following factors may be used as guides:
- Support for energy source.
- Detailed work relating to installation
- Support for relative costs or savings of present energy source compared to alternate energy source.
- Environmental impact (site , etc.) of alternate energy source.
- Support for question 4.

Given the opportunity to select and research an alternate home energy source, the student will be able to determine the factors favorable or unfavorable for its possible use.



Developed by: Ted Parker
Beaverton School District
Beaverton, OR

title: "Conflicts"

sources

concept: Access to energy sources affects the growth of differing technological, social, governmental, economic, and cultural systems.

objective: Given the opportunity to discuss the conflicts related to our uses and sources of energy and resources, the student will be able to understand that changes in cultural patterns may result from our solutions to resource and energy conflicts.

time: 4-5 45 minute class periods

subject matter area: All

grade: 10-12

implementation:

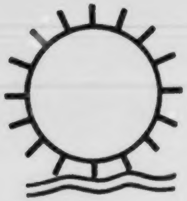
Activity:

1. Divide the class into small groups.

2. Explain to the groups that questions and conflicts will arise within the society that deals with the allocation of resources and energy, and that these questions and conflicts will require answers. The group's job is to select a question or conflict and suggest solutions.

3. Below are listed some questions the instructor may wish to use, or the instructor may develop an alternate list or have the students generate their own list for the class to use.
   a. Can full production be achieved with environmental controls? How?
   b. Can we control population growth without violating the right of privacy? How?
   c. Can technology be counted upon to improve both the quality and quantity of life? How?
   d. Can economic prosperity coexist with preservation of the environment? How?
   e. Can we enjoy a better distribution of earth's energy resources and maintain a higher standard of living for all people? How?

materials:



activity no. 5

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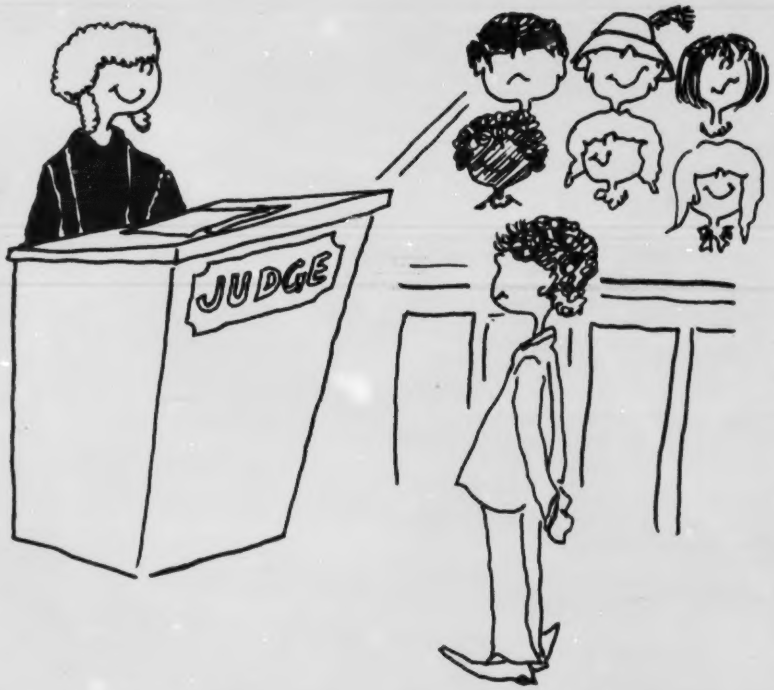
implementation:

Activities: (continued) 4. Have each group present their solutions and discuss them as a class.

SUGGESTED CAREER EDUCATION ACTIVITY:

Given the opportunity to investigate an occupation of particular interest, the student will be able to identify any of the possible conflicts in values the people in the occupation may have with environmental issues.



materials:

SUGGESTED ASSESSMENT PROCEDURE:

Given the opportunity to work in small groups, the student will be able to identify and understand possible solutions to energy and resource conflicts and the possible resultant changes in cultural patterns.

Developed by: Duane K. Altig
Parkrose School District
Portland, OR

title: "Energy Occupations"

sources

concept: Exploitation of different energy sources results in a variety of occupations.

objective: Given the opportunity to select an energy source, the student will be able to list energy related occupations and write descriptive paragraphs of training needed for these occupations.

time: 3-4 45 minute class periods

subject matter area: All

grade: 10-12

activity no. 6

implementation:

Activity:

1. Who is the magic genie that serves us with energy? In order to have energy in a usable and readily available form, many genies are involved. Today, we are going to search for the genies that help us acquire energy. Pick an energy source such as oil, natural gas, gasoline, or electricity. Choose an area of production or distribution of the energy source. Examples: Electrical generation, oil exploration, distribution of natural gas from well-head to consumer.

2. List as many jobs as possible that relate to your chosen area. After you have generated your list, go to an information source and see if there are occupations you might have overlooked. One information source is the Dictionary of Occupational Titles, published by the U.S. Government Printing Office.

3. Now that you have an extensive list, pick out three occupations that require different types of post high-school training. For example, apprentice training, on-the-job training, two years of college, special two-year program, four year college, or training and experience in addition to four years of schooling. For each of the three occupations describe the training and educational requirements.

materials:

Career references
Warn the counseling office.

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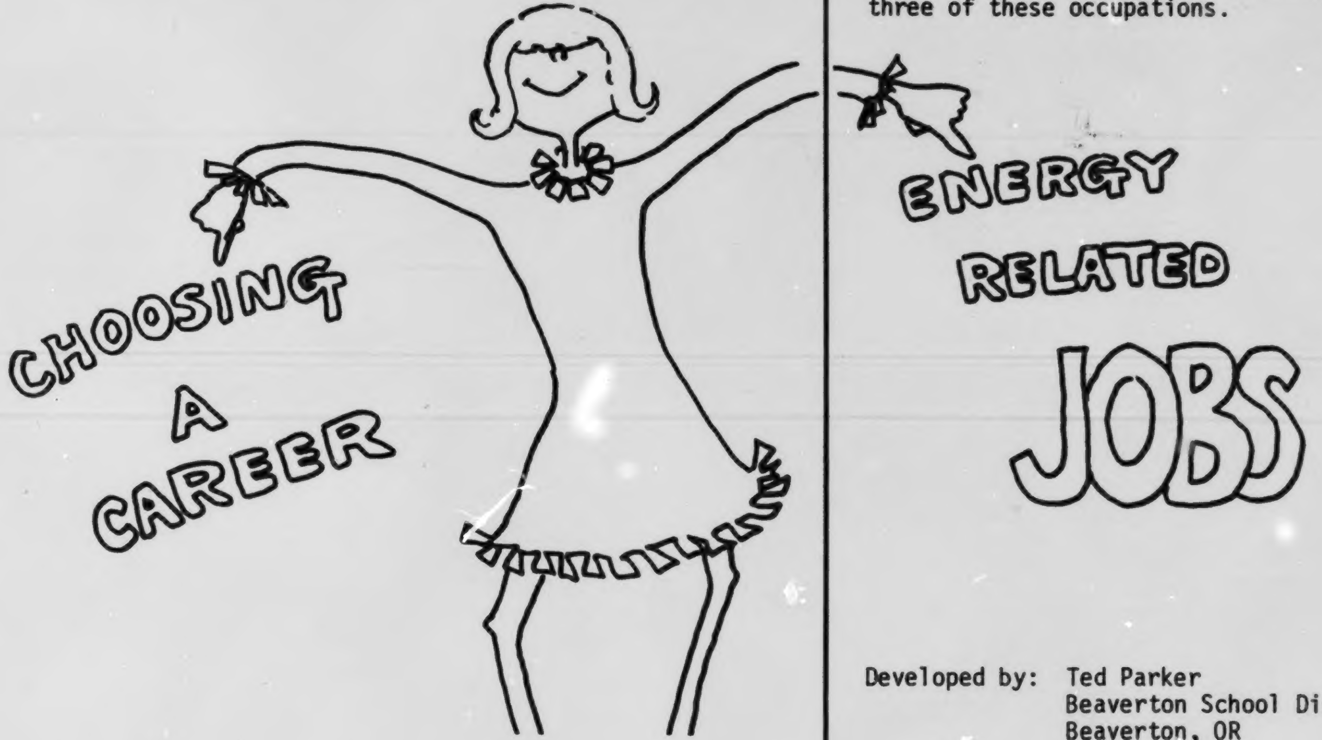
implementation:

Activities: 4. It takes energy to find and train for an occupation. You now have ideas about energy related jobs and training needed to acquire a job. You might want to use this procedure in the future when a career looks interesting.
(continued)



materials:

SUGGESTED ASSESSMENT PROCEDURE:

Given the opportunity to select an area of production or distribution and to list as many jobs as possible, the student will be able to write descriptive paragraphs about the training and/or education needed for three of these occupations.

Developed by: Ted Parker
Beaverton School District
Beaverton, OR

title: "Energy Used In Providing Clothing"

sources

concept: Exploitation of different energy sources results in a variety of occupations.

objective: Given the opportunity to list articles of clothing, the student will be able to identify the sources of energy used in providing clothing.

time: 3-4 45 minute class periods

subject matter area: Social Studies, Language Arts, Career Education

grade: 9-10

implementation:

Activity:

1. List all the garments you wear in 24 hours; these would include shoes, hats, hosiery, swimsuits, etc. Under each garment list all the materials used in making it and the content of the material, i.e., cotton, wool, nylon, polyester, vinyl, leather, metal, etc. With each item identify the sources of energy used in its development.

2. Nothing is manufactured or produced without drawing from sources of energy for the processes involved. Identify all the materials used in making possible the processes for producing your garments. In preparing the list also include transportation needs. With each item include those sources of energy required to produce it and state whether the source is renewable or nonrenewable.

3. As you compile all the information, think of ways people can reduce the demands on the energy sources.
   a. Develop as many ideas as you can, permitting the people of our society to be properly and adequately clothed, yet reducing the energy consumption more than 25%.

materials:

activity no. 7

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implementation:

Activities: (continued) 4. Have each student choose one of the initial objects listed and trace all of the occupations involved in its production, from the source to the finished product.

SUGGESTED CAREER EDUCATION ACTIVITY:

Given the opportunity to hear a speaker on the topic of job interviews, the student will become aware of the significance of grooming in the process of job seeking.

materials:

SUGGESTED ASSESSMENT PROCEDURE:

Have the student:
Enumerate sources of energy used in providing daily essential needs.

Suggest means to conserve those sources in relation to meeting daily essential needs.

Given the opportunity to list a variety of garments worn in a 24 hour period and identify the energy sources used in producing the garments, the student will be able to select one garment and trace all the occupations involved in its production.

Developed by: Mabel M. Lund
Beaverton School District
Beaverton, OR

USES OF ENERGY

GOAL:

IT IS ESSENTIAL THAT EACH PERSON KNOW THAT PEOPLE ARE DEPENDENT UPON ENERGY.

ACTIVITY
DESCRIPTION PAGE

USES (10-12)

Goal: It is essential that each person know that people are dependent upon energy.

Concept: All living things and natural processes require energy.

Activity #1 "Population vs. Food: An Energy Problem"
Grade level 8-10
Health, Science, Social Science

Given the opportunity to participate in classroom tasks, the student will be able to describe at least five causes of inadequate nutritious food supplies for the world's population.

Concept: Each form of energy can be used in many ways.

Activity #2 "Water As An Energy Source"
Grade level 9-10
Science

Given the opportunity to understand the process of electrolysis, the student will be able to learn about the chemical composition of water and the use of water as an energy source.

Activity #3 "Water--Under The Bridge Or Over The Dam"
Grade level 10-12
Math, Physics

Given the opportunity to measure, record and calculate stream channel dimensions and flow rate, the student will be able to calculate the potential energy available in the flowing water.

Concept: Some human technologies and activities use more energy than others.

Activity #4 "Beauty-N-Energy"
Grade level 10-12
All Subject Matter Areas

Given the opportunity to examine items of aesthetic appeal, the student will be able to pick out something s/he considers beautiful that human beings have created and describe the energy input.

ACTIVITY
DESCRIPTION PAGE
USES (10-12)

Activity #5

"High Energy User vs. Conserver"
Grade level 10-12
Social Science, Language Arts, Science

Given the opportunity to participate in a classroom activity, the student will be able to gather data to construct a questionnaire which will determine if a person is a high energy user or a conserver of energy.

Activity #6

"Space Heating; What's Best?"
Grade level 10-12
All Subject Matter Areas

Given the opportunity to complete a report, the student will be able to list and use factors that determine which source of energy will be used in space heating.

Concept: Social, economic, and political pressures influence the efficient and economical use of energy.

Activity #7

"Energy Costs in Pollution Reduction"
Grade level 10-12
All Subject Matter Areas

Given the opportunity to read an article, the student will be able to determine that reduction of pollution costs energy and the effects of this energy use.

Activity #8

"Patterns of Energy Use"
Grade level 10-12
All Subject Matter Areas

Given the opportunity to gather information about local energy use, the student will be able to understand that patterns of energy use for home heating will change with time and location.

Activity #9

"Understanding Graphs Of Energy Use Related To Food Production"
Grade level 10-12
Social Science, Language Arts

Given the opportunity to read an article and several graphs related to food production, the student will be able to interpret the graphs and understand what factors will cause variations in the graphs.

ACTIVITY
DESCRIPTION PAGE
USES (10-12)

Concept:	There are many ways to conserve energy.
Activity #10	"The Costs of Reducing Energy Consumption" Grade level 10-12 Science, Social Science Given the opportunity to participate in a classroom brainstorming activity, the student will be able to find ways to reduce energy consumption at home and the "costs" of that reduction.
Concept:	Every decision made involving energy affects standards of living.
Activity #11	"Things I Like To Do" Grade level 10-12 Social studies (values) Given the opportunity to make a list of things they like to do, the students will be able to examine the items and determine a value for each.
Activity #12	"Leisure Time Activities" Grade level 10-12 Social studies (values) Given the opportunity to participate in a values clarification exercise, the student will be able to become more aware of the relationship between standard of living and energy use.

title: "Population vs. Food: An Energy Problem"

uses

concept: All living things and natural processes require energy.

objective: Given the opportunity to participate in classroom tasks, the students will be able to describe at least five causes of inadequate nutritious food supplies for the world's population.

time: 4-5 45 minute class periods

subject matter area: Health, Science, Social Science

grade: 8-10

implementation:

Activity:

1. Give an essay-type of pre-test to assess students' knowledge of the existing problem of world food supply.
2. Record on a blackboard a tally of the class' perceptions of a proposed problem.
3. Discuss the problem informally in class.
4. Use available reference material to investigate the problem by finding out where most of the world's food is produced. Use maps to pinpoint areas.
5. On a map, mark the major per capita consumers of the world's food.
6. Have the class discuss the differences between the two maps.
7. Identify which one food nutrient is, or should be, in greatest demand yet is obviously in shortest supply worldwide.

materials:

Reference books
Charts
Maps
Paper
Art supplies
Science equipment

equipment:

16mm projector
Slide projector
Overhead projector
Tape recorder
Film strip projector
8mm film loops
Listening posts
Earphones

activity no. 1

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implementation:

Activities: (continued)

8. Research and list all sources of animal and plant protein. Find out how much the average person needs each day to stay healthy. What is the estimated protein intake for most of the world's population?

9. List what happens to the body when deprived of minimum protein requirement.

10. Using movies, filmstrips, slides, books, videotapes, and tape recordings, look for apparent causes of inadequate food supplies. Record these. Many have been identified by scientists and organizations such as the Food and Agriculture Organization and the World Health Organization.

11. Have students cite reasons for their agreement or disagreement with these causes.

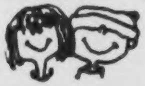
12. Construct prototypes, collect examples through pictures, or perform experiments to illustrate one of the reasons, (i.e., erosion, widespread use of pesticides, pollution) relating to food production.

13. Invite resource people to discuss the causes with the class.

SUGGESTED CAREER EDUCATION ACTIVITY:

Given an opportunity to identify one of the causes of inadequate food supply, the student will be able to suggest a possible solution to the problem and identify present, and/or, future types of occupations which would be involved in solving the problem.

materials:



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INFORMATION SOURCES

Contact State and Federal Departments of Agriculture.

Food & Agriculture Organization
of the United Nations
1776 F Street, N.W.
Washington, DC 20437

Film: "Food Supply: Its Effect On Civilization" Produced by Journal Films. Rentals often available from nearest university film library.

Energy, Food and You is an excellent curriculum guide on this subject. Contact
Shoreline School District
NE 158th and 20th Avenue NE
Olympia, WA 98504

SUGGESTED ASSESSMENT PROCEDURE:

Given the opportunity to participate in a variety of classroom activities, the student will be able to identify five causes of inadequate nutritious food supplies for the world's population.

Developed by: **Rita Paxton**
Whittier Elementary Sch.
Salt Lake City, UT

Revised by: **Duane K. Altig**

title: "Water As An Energy Source"

uses

concept: Each form of energy can be used in many ways.

objective: Given the opportunity to understand the process of electrolysis, the student will be able to learn about the chemical composition of water and the use of water as an energy source.

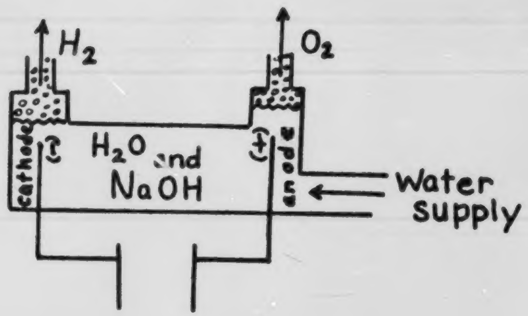
time: Variable

subject matter area: Science

grade: 9-10

implementation:

Activity: 1. Have the students diagram the electrolysis of water.



2. Have the students discuss some of the
   a. uses of hydrogen gas.
   b. means of storing electricity from intermittent sources.
   c. potential fuels for space heating, industrial processes, and transportation.

materials:

Electrolysis equipment

Sodium Hydroxide
or other ionized
solution

activity no. 2

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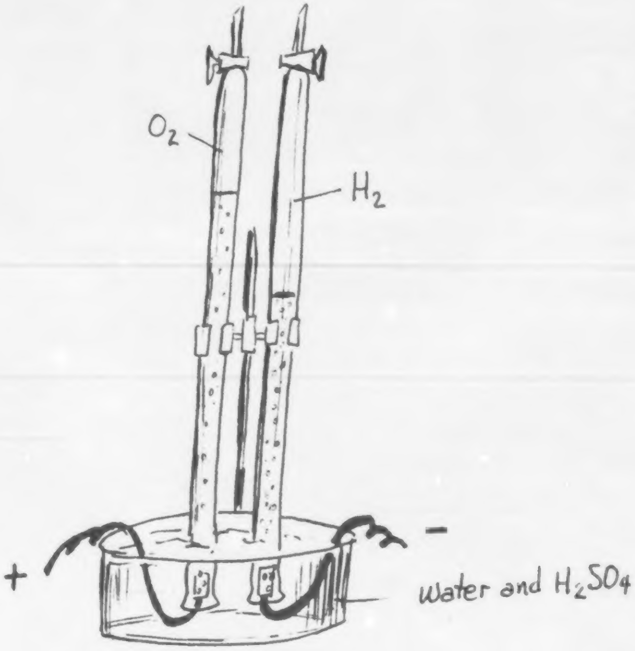
implementation:

Activity: (continued)

3. Advantages of hydrogen fuel in urban areas.
   - a. Hydrogen-fueled devices would elimate hydrocarbons, particulates, SO_2, CO_2, NO_x, and CO pollution problems. Water vapor is the only combustion product when hydrogen is burned as a fuel.
   - b. Use of oxygen as a valuable by-product from electrolysis.



The Electrolysis of Water

materials:

SUGGESTED ASSESSMENT PROCEDURE:

Given the opportunity to discuss the electrolysis of water and the potential use of hydrogen fuel, the student will be able to diagram the electrolysis process and identify several possible uses for hydrogen fuel.

Developed by: Dick Mace
Beaverton School District
Beaverton, OR

title: "Water--Under The Bridge Or Over The Dam"

uses

concept: Each form of energy can be used in many ways.

objective: Given the opportunity to measure, record and calculate stream channel dimensions and flow rate, the student will be able to calculate the potential energy available in the flowing water of the stream.

time: 2 45-min. periods

subject matter area: Math, Physics

grade: 10-12

implementation:

Activity:

1. Locate a small stream, irrigation ditch or drainage channel. Stake out a measured distance (50-100 feet) on the stream bank parallel to the mid channel line.
2. Drop a match stick into the water upstream from the measured distance and determine the time required for the match stick to cover the measured distance. Do this 3 times and find the average time to cover the measured distance. Use the relation Distance = Velocity x Time (D = VT) to calculate the flow rate (velocity) of the stream.
3. Measure the width of the stream at three points along the measured distance staked out in step 1. Find the average of these 3 measurements to determine the average width of the stream.
4. At the mid point of the measured distance along the stream, measure the depth of the stream at least 3 points along a line perpendicular to the bank and across the stream. Find the average depth of the stream at this point.

materials:

measuring tape
meter sticks
wooden or paper match sticks
stop watch

activity no. 3

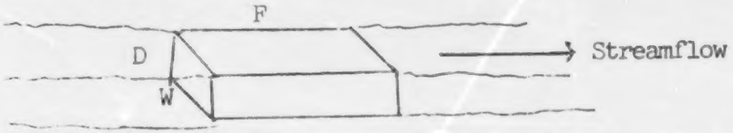
implementation:

Activity: (cont.)

5. The 3 factors determined so far are:

   F = flow rate in feet/second
   W = average width
   D = average depth

   A plane of area W x D sweeps out a volume V = F (WxD) in one second.



6. The volume of water flowing past a given point in the stream is given by

$$\text{Volume} - F\,\frac{\text{ft}}{\text{sec}} \times W\ \text{ft} \times D\ \text{ft} = FWD\,\frac{\text{ft}^3}{\text{sec}}$$

7. Knowing the volume of water flowing past a given point in one second, it is possible to determine the weight of an equivalent volume of water.

$$\text{Weight (lbs)} = \text{Volume}\ \frac{(\text{ft}^3)}{\text{sec}} \times 62.4\ \frac{(\text{lbs})}{\text{ft}^3}$$

8. Allow a volume of water of this weight to fall through distance h. "h" is called the water head. The product Wh is the potential energy contained in this volume of water. Potential energy is measured in foot pounds.

$$\text{PE (ft-lbs)} = W\ \text{(lbs)} \times h\text{(feet)}$$

materials:

implementation:

Activity: (cont.)

9. The time rate of doing work is called power. The power generated by falling water depends on 3 factors:

   i) W = Weight of water released (see step 7)
   ii) h = The head through which the water falls (see step 8)
   iii) T = The time over which the water flows or is released

   Power (foot-pounds/second = $\frac{W(\text{pounds} \times h(\text{feet})}{T(\text{seconds})}$

10. Check a topographic map for elevation changes that your stream flows through. Use this information to determine h for your stream. From this you may calculate the hydro potential for the stream over one minute, one hour, a day, etc.

    Some useful conversion factors:

    1 foot-pound = 1.356 joules
    1 joule = 9.485×10^{-4} BTU
    = 2.39×10^{-4} kcal
    = 2.778×10^{-7} kWh

11. An obvious extension of this activity is to obtain volume, flow rate and head figures for a large hydroelectric facility and calculate the power generated by the plant.

12. Another interesting extension would be to calculate the number of people that could be serviced by your stream flowing at the rate calculated. A typical daily water requirement is 200 gallons/person/day. One cubic foot of water contains 7.48 gallons. One person requires then 200/7.48 = 26.74 ft.^{3}/day. How many people might your stream service in 1 minute? 1 hour? 1 day?

SUGGESTED CAREER EDUCATION ACTIVITY:

Given the opportunity, the student will be able to identify career opportunities related to the use of water in the production of energy.

materials:

SUGGESTED ASSESSMENT PROCEDURE:

Given the opportunity to participate in class discussion, visit a local stream, measure and record data, the student will be able to accurately calculate the potential energy available in the flowing water of a stream and identify uses for this energy.

Adapted from: U.S. Forest Service Environmental Education Notebook

Developed by: David C. Ulmer, Jr.
Mitchell High School
Colorado Springs, CO

title: "Beauty-N-Energy"

uses

concept: Some human technologies and activities use more energy than others.

objective: Given the opportunity to examine items of aesthetic appeal, the student will be able to pick out something he/she considers beautiful that human beings have created and describe the energy input.

time: Variable

subject matter area: All

grade: 10-12

implementation:

Activity:

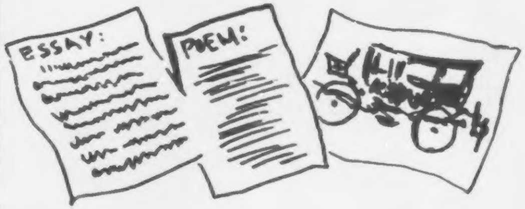
1. Introduction.
   a. Human beings have created many pleasing things. (i.e. art work, parks, artificial water falls, others.)
   b. What kinds of energy go into these projects? Brainstorm for a period of time.

2. Assignment.
   a. Pick something human beings have made that you consider beautiful.
   b. Describe the energy that goes into producing the item. (Sources, conversions, etc.)

3. Methods of describing.
   a. Writing.
   b. Pictures, stills, 8mm, etc., cut outs from magazines.
   c. Drawings.
   d. Poems.
   e. Tape recordings.

4. Share findings.

materials:



activity no. 4

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implementation:

Activities: (continued) 5. Note: You may want or need a discussion on what is beautiful that human beings have made. Define "beauty."

SUGGESTED CAREER EDUCATION ACTIVITY:

Given an opportunity to select an occupation of interest, the student will be able to identify the opportunities for leisure time pursuits offered by the selected occupation.

materials:

SUGGESTED ASSESSMENT PROCEDURE:

Given the opportunity to select an item of aesthetic appeal, the student will be able to describe, in a manner of individual selection, the energy input for the selected item.

Developed by: Ted Parker
Beaverton School Dist.
Beaverton, OR

title: "High Energy User vs. Conserver"

uses

concept: Some human technologies and activities use more energy than others.

objective: Given the opportunity to participate in a classroom activity, the student will be able to gather data to construct a questionnaire which will determine if a person is a high energy user or a conserver of energy.

time: 5-6 45 minute class periods

subject matter area: Social Science, Language Arts, Science

grade: 10-12

implementation:

Activity:

1. What are the factors that distinguish a high energy user from one who conserves? Is it possible to develop a questionnaire that will indicate if a person is a high energy user or a low energy user? This is a problem which we will attempt to solve. First, let's list some actions or situations that might contrast a high energy user with one who is conserving. You may want to have small groups, 3-4 people, generate lists on large newsprint or butcher paper. Then post lists around the room and develop a composite.

2. When the students have completed the list, the next task is to develop questions. The purpose of the questions is to determine if the person or group is a high energy user or a conserver.

3. Before having students write questions, discuss the types of question-answer formats.

materials:

activity no. 5

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implementation:

Activities:
(continued)

Type	Advantage	Disadvantage
Open response or interview	Respondent writes or talks with only the question as a guide. Maximum response.	Hard to classify answer. Much time involved.
Limited choice 1-5 scale or 1-3 scale.	Gives respondent a controlled choice which is easier to classify.	May not have intent or feelings of responder.
Yes - no	Easy to classify.	Very limited for responder.

4. Have students write a questionnaire based on the method selected. They choose the number of questions.
5. The testing of the questionnaire should follow, but if there is a time limit go full scale. Testing should involve some people who are known to fill each category. The point is to have questions that will distinguish between the attitude, action, ideas, feelings, etc. of a high energy user and a conserver.
6. Have students discuss their findings. Data should be presented in ordered form using percentages or decimals, comments, and other analytical methods, but not in raw form.

SUGGESTED CAREER EDUCATION ACTIVITY:

Given the opportunity to construct a questionnaire, the students will be able to identify occupations which tend to be higher energy users in relation to other occupations.

materials:

SUGGESTED ASSESSMENT PROCEDURE:

Questions and questionnaire;
- were they done?
- was it used?

Data analysis;
- data gathered (raw form)?
- data analyzed?
- data presented?

General participation.

Given the opportunity to participate in the development and use of an energy user's questionnaire, the student will be able to participate in classroom discussions related to the findings from the questionnaire.

Developed by: Ted Parker
Beaverton School District
Beaverton, OR

title: "Space Heating; What's Best?"

uses

concept: Some human technologies and activities use more energy than others.

objective: Given the opportunity to complete a report, the student will be able to list and use factors that determine which source of energy will be used in space heating.

time: Variable

subject matter area: All

grade: 10-12

implementation:

Activity:

1. Introduction: We use approximately 30% of our energy for space heating. We heat homes, basements, garages, office buildings, condominiums, single homes, high-rise apart- some time. The space heating improves the environment so we may be more comfortable. What is the best energy source to use for space heating?
    a. Note: You may wish to change the situation to more closely fit your area. For example, large apartment

       ments or combinations. You may also desire to have students work in groups of 2-3 rather than individually.

2. Problem: You are a member of a consulting engineering firm and your training is in environmental research and application. Mr. James T. Bigmoney has come to your firm to find out the best heating sources for his exclusive community. Your job is to list the factors that are to be considered and the effects of those factors.
    a. During your research you found three articles, "All-Electric Residence Conserves Energy," "Does Electric Heating Waste Energy?" and "Environmental Impact as a Criterion in Heating System Design," that might get you going. Read these articles. Note the factors considered and not considered.

materials:

Three articles (attached)

"Environmental Impact As A Criterion In Heating System Design," Ashrae Journal.

"All-Electric Residence Conserves Energy," Electrical World.

"Does Electric Heating Waste Energy?" Electrical World.

(Note: These articles were published in 1972-73. The information they contain is still useful. However, you may wish to consult the Reader's Guide to Periodical Literature for more recent articles.

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implementation:

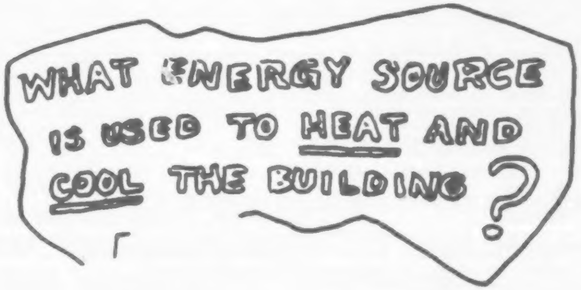
Activities: (continued)

b. Now you are started on Mr. Bigmoney's report. Use factors you consider important. Your position will be stronger if you emphasize facts and figures rather than your feelings.

3. Instructor: You may wish to contact your local power company and find someone who might discuss how the power company figures the impact of new developments.

SUGGESTED CAREER EDUCATION ACTIVITY:

Given the opportunity to select an occupation related to the use or production of energy, the student will be able to identify the high school courses which would provide basic skills or knowledge for the selected occupation.



materials:

Consider the following:

- Factors included in report.
- Quantification (costs, estimation of power use, where the electric power is to be generated)
- Impact on local power generation facilities; fuel transportation. fuel transportation.
- Did the data support the recommendation?
- Tables, graphs, visual aids.

SUGGESTED ASSESSMENT PROCEDURE:

Given the opportunity to gather the necessary information, the student will be able to list the factors that determine which energy source is to be used in space heating.

Developed by: Ted Parker
Beaverton School District
Beaverton, OR

"Environmental Impact as a Criterion in Heating System Design" by Simon K. Mencher, Adel Hakki, and Michael S. Rolinski has been removed by ERIC due to copyright law.

All-electric residence conserves energy

This headline should not come as a surprise to anyone in the electrical industry. Unfortunately, the public is showing signs of believing just the oposite. Opponents of electric heat are jumping on what is becoming a "political/environmental" bandwagon, and spreading the word that all-electric residences are depleting fuel reserves. Many of their statements are made in the form of inferences coming from "outside theorists." Very few have their origin in actual case histories. Nevertheless their theories are of concern.

Specialists in Florida Power Corp's Marketing Dept recently surveyed two similar residences. One residence is all-electric and equipped with two heat pumps; the other is heated and cooled with gas. In analyzing and comparing data from these residences they found that the all-electric home:

- Required 40% less energy in terms of total Btu;
- Released considerably less heat into the total environment;
- Costs 11¢/sq ft less to operate.

"Total environment" is defined as the area around the power plant and neighborhood of the residence.

Cost figures (see table) are based on actual billing data of each residence and physical surveys. One residence for example, with 1,625 sq ft and all-electric, costs $409.61 a year to operate—or, 25¢/sq ft/yr. The gas residence with 1,650 sq ft, costs a total of $601.31 for both gas and electric—or 36.4¢ a sq ft/yr. Cost of the make-up water consumed by the gas absorption unit isn't included in these figures.

The basis for the statements—"the all-electric residence required 40% less energy" and "released considerably less heat"—came from the consumption data of the residences, Florida Power's Generation Cost Analysis report, and use of an unofficial theoretical term, Environmental Energy Requirements (EER).

The EER is defined as "the amount of heat released to the environment—on-site and at the power plant." It's derived by converting annual therms of gas used in the home into Btu plus the kwhr needed by each home into Btu required at the power plant. The latter includes allowances for transmission losses. It does not include the energy used to bring the gas or oil from the well to the home or power plant. It is a method of measuring the "total effect" on the "total environment."

As an example, to supply 22,582 kwhr a year to the all-electric residence, the EER equals 245 million Btu; for the gas home, it totals 418 million Btu for the 12,664 kwhr and 2,808 therms used in a year. Therefore, it can be seen that the all-electric home required less total energy—Btu—and released only half as much heat into the total environment as the gas home. For the winter months of January to April and November and December the all-electric EER equals 113 million Btu for 10,426 kwhr; the gas, 143 million Btu for 5,120 kwhr and 879 therms, and is further proof of how much energy all-electric residences can conserve.

We do not feel that "apples and oranges" have been compared because:

- Each residence is located in the same neighborhood—near Clearwater;
- The same contractors built and insulated both homes;
- Floor plans are almost the same;
- Four people occupy each home;
- Each residence has the same size prefab unheated swimming pool with a circulating filter pump.

User habits are probably the only variable. The homes are kept at about the same temperature. Owners of the all-electric home, however, are more liberal in their use of equipment. They leave the comfort conditioning system on automatic all the time, even when on vacation. Owners of the gas home are more careful and either turn their unit off or reset the thermostat while away from home and in milder weather. Had they been as liberal with their utility service as their all-electric neighbors more than twice as much heat could have been released into the environment by their gas home.

The all-electric home is equipped with two 2-ton heat pumps and the usual number of other major electric appliances. The gas home has a 5-ton water-cooled, absorption-type gas air conditioner, space heating, cooking, water heating, and an electric clothes dryer.

The heat pumps of the all-electric residences are 3-4 times more efficient than the absorption unit. Experience has proven this. But not everyone, particularly the general public, realizes that in addition to being more efficient, the heat pump, a major item of use in all-electric homes, also conserves energy.

One can select other examples showing how all-electric residences supposedly waste energy. However, no such assumption can be made on a broad basis, as most all-electric residents actually require less energy than do gas homes when the "total effect" on the "total environment" is considered.

You've heard the saying "Everybody's talking about the weather but doing nothing about it?" Well, plenty of people are talking about the environment. And, they're seriously going to try and do something about it. Legislation for energy conservation is being proposed; several government agencies, departments, etc. are being formed to find solutions to the problem; and unfortunately our future citizens, our youth, are hearing only one side of the story. ■

By: Ralph Ewart, Research Assistant, Application Engineering & Research, Florida Power Corp, St. Petersburg, Fla.

Comparison of residential utility use and cost—1971

	Electric and gas residence					All-electric residence	
Month	Kwhr	Electric cost	Therms	Gas cost	Total cost	Kwhr	Cost
Jan.	830	$18.57	109	$17.72	$36.29	1698	$31.27
Feb.	714	16.48	133	19.64	36.12	1932	34.8[illegible]
March	740	16.95	118	18.44	35.39	1702	31.3[illegible]
April	858	19.07	118	18.44	37.51	1402	26.8[illegible]
May	774	17.56	82	15.56	33.12	716	31.5[illegible]
June	968	21.41	64	14.12	35.53	1240	24.17
July	1690	33.01	430	43.40	76.41	1390	26.4[illegible]
Aug.	1576	31.13	502	49.16	80.29	1792	32.77
Sept.	1268	26.05	358	37.64	63.69	2754	47.64
Oct.	1248	25.72	493	48.44	74.16	3264	55.59
Nov.	1152	24.14	325	35.00	59.14	1566	29.2[illegible]
Dec.	826	18.58	76	15.08	33.66	2126	38.11
Total	**12,664**	**$268.67**	**2,808**	**$332.64**	**$601.31**	**22,582**	**$409.[illegible]**

Annual degree days: heating—502; cooling—4,164

Does electric heating waste energy?

Utility study shows that energy consumed in single-family home is not a function of energy source used; life-style and construction standards are more significant factors

There is little significant difference in the consumption of raw energy, whether a home uses gas or electricity for heating, cooling, water-heating, etc. This is the conclusion of a study of over 300 single-family homes conducted by Oklahoma Gas & Electric Co.

The study revealed that approximately 200,000 Btu per sq ft per year will be consumed by a home in OG&E's service area regardless of the type of heating, air-conditioning, or water-heating system used. Significantly, the study found that a family's living habits, and initial home-construction standards, are the factors with most effect on energy use.

The study completely rejects any assumption as to the burning efficiency of fossil fuels, and relies instead on actual metered consumption and actual heat rates at the generating station. OG&E feels strongly that this can be the only reasonable approach to the question of end-use efficiency of natural resources.

The company fully recognizes that the conclusion of its study contradicts much of the information published today, which characterizes the use of fossil fuels to generate electricity as a wasteful process. OG&E's position is that, in the final analysis, the gas it burns at its generating stations will be consumed at about the same efficiency as when it is burned in a furnace or water heater in a single-family home.

The reason for the disparity between theory and practice can be summed up with two main points. First, the commonly assumed burning efficiency of a gas-fired heating system does not approach the 70% or 75% efficiency quoted in the Ashrae Guide, when measured on a seasonal basis. The 70% figure in the guide is based on laboratory conditions, and neglects losses associated with dirty burners, pilot lights, and the time required to heat the furnace bonnet before heat is delivered to the home.

A Georgia Power Co study made several years ago indicated that the overall burning efficiency of such a system under field conditions is more nearly 40%.

The second point is that a gas-fired furnace in a single-family home requires 10,000 cu ft of combustion air per 1,000 cu ft of natural gas consumed. Because the furnace's combustion air can only come from outside air, if the asphyxiation of the occupants is to be avoided, it's easy to see that a gas-fired heating system increases the heating load on a residential structure. This heating load is, of course, over and above that which must be handled by an equivalent electric heating system. Similar results occur with any other fossil-fueled heating system.

Single-family-home energy requirements

Description	Equipment	No. of houses	Total sq ft	Btu consumption	Ave Btu per sq ft/yr
Total electric, central systems	Heat pump	14	32,015	5,235,356,610	163,528
	Electric furnace and electric A/C	213	358,451	74,262,939,300	207,177
	Total	227	390,466	79,498,295,910	203,598
Combination, central systems	Gas central furnace and electric A/C	19	26,575	5,115,091,130	192,477
	Gas central furnace and gas A/C	30	54,582	13,132,029,330	240,592
	Total	49	81,157	18,247,120,460	224,837
Total electric	Electric baseboard and ceiling cable	34	49,475	9,012,607,560	182,164

Note: Gas and electric distribution losses not included. Baseboard and ceiling-cable installations do not have duct losses associated with central space-heating systems.

The OG&E study was based on metered consumption of all-electric homes, and of combination gas-and-electric homes. The figure for the number of cubic feet of natural gas required to generate a kwhr of electricity was based on the company's published heat rate of 10,890 Btu per kwhr. The figure for the amount of gas used directly by the customer was taken at a heat content rating of 1,025,000 Btu per Mcf.

No attempt was made to account for the impedance losses in the company's electric system; by the same token, no attempt was made to account for the energy required to transport natural gas, or the leakage in the pipeline system. The utility feels that losses from either of these sources would be between 5% and 8%, and thus would not materially affect the end result of the study.

A somewhat similar study with similar results, involving ten office buildings in New York City, was made by Fred Nicholas Inc, consulting engineers of State College, Pa. (EW, April 15, 1972, p 104). Nicholas found that all-electric buildings used less energy per square foot than buildings with a combination fossil-fuel/electric-energy system. This study has since been revised twice—once last May to cover 73 residential and 56 commercial buildings in the Northeast; again in December covering 91 residential and 68 office buildings.

Another study, by Gordian Associates Inc, New York, on the environmental impact of electric vs fossil-fuel space-heating for the Welfare Island Development Project, also concludes that electric heating is not wasteful of natural resources. ■

title: "Energy Costs in Pollution Reduction"

uses

concept: Social, economic, and political pressures influence the efficient and economical use of energy.

objective: Given the opportunity to read an article, the student will be able to determine that reduction of pollution costs energy and the effects of this energy use.

time: 1-3 45 minute class periods

subject matter area: All

grade: 10-12

implementation:

Activity:

1. Introduction:
   a. Brief over-view of what is done to clean up the environment.
   b. What do our clean-up or low-pollution actions mean in terms of energy?

2. Task:
   a. Student reads "Energy Needs for Pollution Control" (attached) and/or other related material.
   b. Have student respond about the validity of the article. Cite specific points.
   c. Have students respond (written, oral, drawing, etc.) to "Is this the only way to go?" You could set up a panel to discuss. Have students explore the alternatives.
   d. Have students find out the effects of reduction of pollution on local or regional electrical energy production. Findings might be expressed in graphs, pictures, written, oral, etc.

materials:

Energy And Man: Technical And Social Aspects of Energy, M. Granger, Moran, ed., IEEE Press, 1975.

Selected articles from above:
"Environment: A Delicate Balance Of Costs And Benefits," p. 134.

"The Economic Costs of Air Pollution Damages," p. 424.

Ecology And Economics: Controlling Pollution In the 70's, Marshall I. Goldman, Prentice-Hall, Inc.

The Economics Of Environmental Protection, Donald N. Thompson, Winthrop Publishers, 1973.

activity no. 7

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implementation:

Suggestions as to points students might have touched:

a. Validity of article:
  - time of writing
  - figures
  - accurate references
  - overall idea

b. Alternatives:
  - let "things" go
  - controls to fit area
  - trade-offs

c. Effect on regional power production:
  - Assessment of present situation
  - Projection
  - Dollar costs in terms of increased generating facilities

SUGGESTED CAREER EDUCATION ACTIVITY:

Given the opportunity to rank order a set of values related to energy use and pollution, the student will be able to relate the influences these values may have upon career selection.

materials:

SUGGESTED ASSESSMENT PROCEDURE:

Given the opportunity to gather and discuss the necessary background data, the student will be able to express in a selected manner the effects of reduction of pollution on local or regional electrical energy production.

Developed by: Ted Parker
Beaverton School District
Beaverton, OR

From: Environmental Health Energy & the Environment
Energy Information Services, Inc.
229 Seventh Avenue
NY 10011

ENERGY NEEDS FOR POLLUTION CONTROL*

POWER FOR THE ENVIRONMENT

No matter whether the U. S. electric power consumption nearly doubles every 10 years, as now seems likely, or expands at some lesser rate, it is evident that electric energy will increasingly be called upon to combat the environmental degradation that offends us all. The point was well made in a New York Times column by Robert Bendiner, a member of that paper's editorial board: "...we need more (electric) power to do the very recycling of waste that is so desirable. We need it to operate the vastly expanded sewage treatment plants that a growing population demands. We need it for that immeasurably developed system of mass transportation that our metropolitan areas must have if the automobile is not to make the human lung outmoded. We need it for the herculean cleanup of the nations' lakes and rivers. And, not least, we need it if all who are just emerging from dire poverty are to enjoy a standard of living we have so come to take for granted that many now hold it in scorn or pretend to."

Although public speakers and the news media increasingly recognize the coming demands of these energy-intensive environmental programs, few have been able to translate the scope of energy needs into kilowatts and kilowatt-hours.

(To place kilowatt-hour (kwh) figures into better perspective, note that in 1970 the average American household consumed 7,000 kwh.)

POLLUTION CONTROL

Several Pacific Northwest metal smelters use more than 60-million kwh per year each for control of air and water pollution alone. That's equivalent to the electrical consumption of 8,500 typical households.

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*Atomic Industrial Forum, Inc., New York.

In Chicago, Commonwealth Edison Co. reports that eight out of 13 area foundry and steel-making facilities have converted from polluting processes to electrical power. Recently, U.S. Steel and Republic Steel alone have asked Commonwealth to supply more than 200,000 kilowatts of additional power for electric furnaces and other purposes, thus more than doubling their total electric requirements.

An electrostatic scrubber for a large industrial plant requires as much as 50,000 kilowatts of capacity.

A 1970 survey by the Bonneville Power Administration showed that of the two million homes served by electricity in the Pacific Northwest, 25 percent were heated electrically. Based on an average unit consumption (for that region) of 12,000 kwh annually, this totalled 6-billion kwh per year for heating use only. The other 1.5-million Pacific Northwest homes were heated by oil (50 percent), gas (18 percent) and coal and wood (7 percent), and BPA estimates that their heating plants contributed 38,000 tons of particulate matter to air pollution last year. Northwestern utilities anticipate that power demand for home heating will more than triple by 1990, when 50 percent of the projected 3.5-million homes in that region will be heated electrically.

The efficient disposal of garbage and trash is calculated by some experts to require as much as 2-million kilowatts for the country as a whole. There may be some trade-offs if incinerators can be designed to produce rather than to consume power, but the control of air pollution caused by the burning of garbage and sewage will in turn require substantial amounts of electric energy.

SEWAGE TREATMENT

Primary sewage treatment requires 21 kwh per year per person, according to a survey of Oregon and Washington State communities. Secondary treatment, which most American municipalities do not yet have, raises this to about 38 kwh/year/person.

The Federal Water Quality Administration calculates that in 1968 the U.S. consumed close to 2-billion kwh for sewage treatment. It estimates that in 1973 the needs of an urban population of 165-million Americans will require that this be more than doubled, to 4.6-million kwh, or 28.1 kwh/year/person.

RECYCLING

A conceptual design of a total recycling plant, commissioned by the Aluminum Association, envisages a facility that would take in garbage at one end and produce saleable raw materials at the other. Designed to serve a city of 175,000 to 200,000 people, such a plant could consume nearly 10-million kwh per year.

In 1969, some 20-million tons of scrap iron and steel were reclaimed in the U.S., mostly by means of electric furnaces, and this total is even higher today. Metal industry sources say that to recycle one ton of scrap requires 500 kwh of power, which would mean 1969 consumption for this purpose of 10-billion kwh.

One Chicago plant, typical of its kind, uses nearly 4,000 kilowatts of electrical power to grind up junk automobiles into metal shreds for remelting.

STREET LIGHTING

General Electric reports that even with a highly efficient lamp, such as its 400-watt Lucalox, it takes 44,000 kwh per year per mile to properly illuminate a four-lane street and 66,000 kwh/year/mile for a six-lane highway. The 1,000-watt mercury clear lamps in common use today require approximately three times as many kilowatts per foot candle as the Lucalox, according to G.E.

MASS TRANSPORTATION

There are some 110-million registered motor vehicles in America, each traveling an average of 10,000 miles a year. That's a trillion miles. To convert just a fraction of that mileage from internal combustion power to electric propulsion would take a great deal of energy. Chargeable batteries used in several experimental electric vehicles by the Eugene, Oregon, Water & Electric Board draw about 1 kwh for each mile of travel. Bruce C. Netschert, a prominent energy consultant, has estimated that the ultimate conversion of this vast automobile fleet to electricity would require approximately 450-billion kilowatt hours, or about a third of the total U.S. output today.

The 160-mph Metroliner railroad cars developed for the Northeast Corridor are designed for maximum acceleration and deceleration. Each Metroliner car has a peak energy demand of 2,500 horsepower, or 25,000 hp for a 10-car train. This is equivalent to an electrical load of nearly 15,000 kilowatts. Although the Metroliner does not draw peak loads continuously, it does require close to full power a good 50 percent of the time because the train automatically changes speed almost constantly as it negotiates the conventional roadbed. If the train operates 70 percent of the time over the course of the year its average power requirement could run to 45-million kwh.

There are about 220,000 miles of railroad track in this country, of which barely 1 percent is electrified. Power required to move loads over electrified lines can go as high as 20 kwh per 1,000 gross ton miles of expedited traffic, according to General Electric's Transportation Systems Division. A rule of thumb among railroaders when estimating power consumption is 1-million kwh per year per mile of electrified track.

The Washington, D.C., Metro subway system, now under construction, will require 500,000 kilowatts annually, which is equivalent to the output of a good-sized generating station.

The biggest urban electric utility in terms of capacity is Consolidated Edison Co. of New York, and Con Ed's biggest single load factor is mass-transit - the city subways and commuter railroads. Last year, Con Ed sold 2.8-billion kwh--8.5 percent of its total--for mass transit use. Energy Consultant Bruce Netschert estimates that electric mass transport for our 25 largest cities would require about 20-million kilowatts of added electric power today--5 percent of the nation's total electric capacity.

title: "Patterns Of Energy Use"

uses

concept: Social, economic, and political pressures influence the efficient and economical use of energy.

objective: Given the opportunity to gather information about local energy use, the student will be able to understand that patterns of energy use for home heating will change with time and location.

time: Variable

subject matter area: All

grade: 10-12

implementation:

Activity:

1. Introduction. (Lecture - discussion)
    a. Use of energy for home heating.
    b. Parts of the country differ in type of energy used (gas, oil, electricity). People's preference for home energy source is changing.

2. Have students read "Fuel Preference Shows Little Change," and discuss with the students methods to "update" the article.

    Suggested methods to update the article.
    a. Survey.
    b. New home and conversion statistics from gas, electric, and oil companies.

3. Have student update the article.

4. Discussion questions from student-collected information.
    a. How does the present heating fuel preference compare with the past?
    b. Do local figures follow the trend shown in figure 2 starting in 1971?

materials:

"Fuel Preference Shows Little Change," Electrical World, May 15, 1973.

FUEL PREFERENCE SHOWS LITTLE CHANGE

activity no. 8

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implementation:

Activities: (continued)

c. How do people feel about the environmental impact of their heating fuel?

d. How do people feel the cost of their heating fuel compares to others? (See table II)

5. If a survey is to be used, have students try it on a small group before expanded use.

SUGGESTED CAREER EDUCATION ACTIVITY:

Given the opportunity to conduct a survey in changes in patterns of energy use, the student will be able to relate the implications of the survey to their career interests.

materials:

SUGGESTED ASSESSMENT PROCEDURE:

Given the opportunity to complete the gathering of the necessary information, the student will be able to, through class discussion of questions, assess any local changes in energy used for home heating.

Developed by: Ted Parker
Beaverton School District
Beaverton, OR

Revised by: Duane K. Altig

Fuel preference shows little change

There has been no significant change in the preference for electric heat nationally, but regional shifts appear to be developing, possibly due to environmental pressures

There does not seem to be any significant shift in the pattern of preference for heating from that which has prevailed for the past six years (Fig 1), says the Electric Energy Assn. The preference for electric heating remains within the 30-40% range; gas within the 40-50% range; and oil is staying constant at about the 10% level.

Regionally (Table I), some shifts appear to be starting to develop, says EEA. In the Northeast, gas has improved its position in relation to electricity and oil. In the North Central region, the same is true, but to a much lesser degree. In the South, electric heating again tops gas in preference, and shows some indication of establishing this on a permanent basis. In the West (Fig 2), however, there was a sharp increase in the preference for gas for heating, and a drop in preference for both electricity and oil.

It could be, EEA says, that the shifts in the Northeast and West reflect increased "environmental pressure."

Estimated heating costs

Attitudes toward the cost of heating have been relatively constant since EEA began surveying heating preferences.

Table I: Regional heating fuel preference, 1972

	Electric	Gas	Oil
US	33	48	11
Northeast	27	36	22
New England	33	24	35
Middle Atlantic	26	40	19
North Central	31	58	5
East North Central	32	58	5
West North Central	28	59	5
South	42	38	11
South Atlantic	44	28	20
East South Central	38	43	2
West South Central	40	52	1
West	28	63	3
Mountain	35	49	11
Pacific	26	68	2

Those using gas or oil heat (Table II) think electric heat would cost about 50% more; those using electric heat think gas or oil heat would range from about the same as electric to 10 to 15% less. Those using either gas or oil think the other fossil fuel would be about 10% to 20% more expensive than the one they are now using.

Table II: Average estimated fuel costs, 1972

	Gas	Oil	Electricity
Fuel now used			
Gas	$100	$123	$147
Oil	$108	$100	$150
Electricity	$ 91	$ 98	$100

Gas users, on the average, estimate electricity costs $147, or 47%, more compared to their present (base = $100) gas costs, and that oil costs 23% more than gas

As in prior surveys, users of electric heat show a higher degree of satisfaction. More of them say they would repeat the installation of electric heating compared to users of either gas or oil heat when asked whether they would use their fuel again. For example, 78% of electric-heat users would prefer it in a new home, compared to 67% of gas-heat users and 33% of oil-heat users. Also, slightly more women than men prefer electric heating; this is not the case with gas or oil.

The EEA survey shows that the public feels electric heating far outstrips gas and oil as contributing least to overall air pollution. Some 70% feel electric

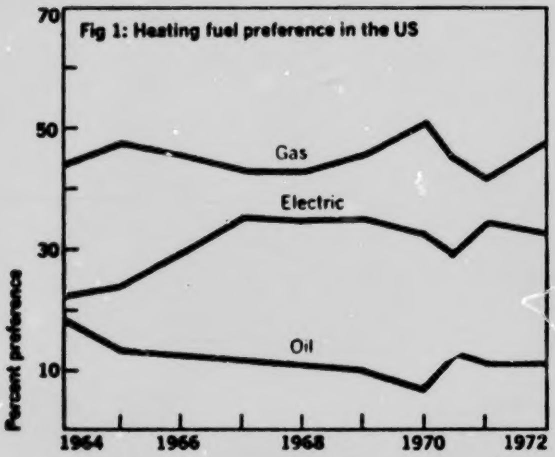

Fig 1: Heating fuel preference in the US

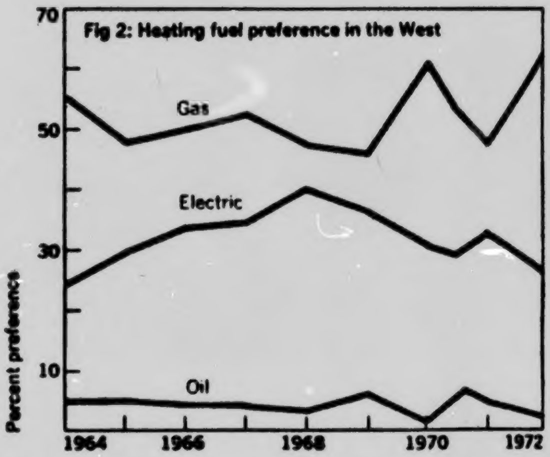

Fig 2: Heating fuel preference in the West

heat is superior in this area, compared to 15% for gas and only 4% for oil. Regionally, there are significant differences, however. In the Northeast, 60% think electric heat contributes *least* to pollution. In the North Central, South, and West, the figures are 71%, 75%, and 72% respectively.

Central air conditioning was rated as important in a new home by 63%. Some 49% indicated they have some form of air conditioning in their homes. As might be expected, this varied with education and income. Some 39% of those with some high school or less had air conditioning, but 52% of those completing high school and 56% of those who attended college had air conditioning. The presence of air conditioning also peaked with age, at 52% to 53% for those in the 25-to-44 age category. Interestingly, apartment dwellers preferred room or individual units (55%) to central systems (33%), while people in single-family homes preferred central units (52%) to room units (39%).

Reduced usage

Consumers reacted to increased costs of electricity by indicating an increasing willingness to attempt to cut down the amount of electricity they would use. In reaction to a 10% increase in cost of electricity, 38% indicated they would attempt to cut down usage. At a 40% cost increase, 70% of consumers indicated a willingness to cut down. In all cases, and at all levels, the women indicated a greater sensitivity to this question and a more definite reaction to increased costs.

When asked what they would cut down, if they wanted to do so, 41% said outdoor lighting, 40% said indoor lighting, 22% said TV, and 20% said the dryer. In each case, the women seemed slightly more willing to cut back in these categories than the men, except for outdoor lighting, where there was no difference in willingness to cut back. EEA added, however, that suggested cutbacks, as far as specific appliances are concerned, do not seem to indicate, as yet, that significant reductions in use would result.

The latest EEA survey is the result of personal, in-home interviews with men and women 18 years of age and older living in private households in the US. Interviews were made between mid-October and early November, 1972. Individuals were chosen on the basis of probability-sampling techniques, permitting projection of the sample to the total adult population. ■

title: "Understanding Graphs Of Energy Use Related To Food Production"

uses

concept: Social, economic and political pressures influence the efficient and economical use of energy.

objective: Given the opportunity to read an article and several graphs related to food production, the student will be able to interpret the graphs and understand what factors will cause variations in the graphs.

time: 1-2 45 minute class periods

subject matter area: Social Science, Language Arts

grade: 10-12

activity no. 9

implementation:

Activity:

1. We are going to read the article "U.S. Agriculture is Growing Trouble as Well as Crops," and examine some graphs that are related to uses of energy and food production. (You may wish to give an example.) This may be done individually, in small groups, or as an entire class.

2. When you have read the graphs, discuss the factors that went into each graph.

Graph I. Energy impact includes: farm machinery and tractors, direct fuel use, electricity, processing, packaging, transportation, home refrigeration and cooking, commercial refrigeration and cooking.

The U.S. puts in various kinds of energy for food production.

Graph II. As the amount of energy input increases, the farm output increases.

materials:

Pages containing three graphs (attached)

Article: "U.S. Agriculture Is Growing Trouble As Well As Crops" (attached)

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Activity No. 9 (page 2)

implementation:

Activities: (continued)

Graph III. Much of our U.S. food production is intensive.

1. High protein foods (meat, eggs, milk) have poorer energy returns than plant foods.
2. Fish protein concentrate will probably not solve the world's food supply problem.
3. Soybeans are a good source of protein.
4. Rice cultures.
5. Need either new sources of energy or less intensive food production.

3. The class will discuss the factors that determine changes and variations in the graphs and the results of these changes and variations.

materials:

SUGGESTED ASSESSMENT PROCEDURE:

Given the opportunity to review the necessary information, the student will be able to relate, through participation in a class discussion, how energy influences food production.

Developed by: Ted Parker
Beaverton School District
Beaverton, OR

Revised by: Duane K. Altig

U.S. AGRICULTURE IS GROWING TROUBLE AS WELL AS CROPS

Wilson Clark

Until recently, most Americans have taken an adequate supply of food for granted. The great productivity of agriculture in this country is still seen as the best available hope for assuaging the international food crisis. But the American system of agriculture is beginning to show signs of wear.

The key to U.S. food production--and what some also see as its weakest link--is that our farms have become dependent on fossil fuels, rather than on human or animal labor. In a study made for the Office of Civil Defense by the Stanford Research Institute, the dimensions of the energy dependence of agriculture become clear. "We can state immediately," said the authors, "that without petroleum, field crop production is virtually impossible in the United States (agricultural) system."

A basic use of energy on the farm is for powering machines--for planting, spraying, fertilizing and harvesting crops. Economist Michael Perchman of California State University at Chico points out that powering the more than five million tractors in the United States requires eight billion gallons of fuel--the equivalent of the energy content in the food produced. In a very real way, the food products on our tables today are produced as much by dead plants (the fossil fuels) as by living ones. (Recently, several oil companies have begun experimental programs to produce single cell protein directly from fossil fuels, bypassing the fields altogether and linking the human food chain directly to nonrenewable resources.)

The production of fertilizers and farm chemicals such as pesticides and herbicides requires extensive use of fossil fuel energy. Studies made by Barry Commoner and his associates at Washington University in St. Louis indicate that, between 1946 and 1968, nitrogen fertilizer and pesticide use in farming increased 534 percent and 217 percent, respectively.

According to Commoner, in 1949 about 11,000 tons of nitrogen fertilizer were required to produce the equivalent crop yield per acre in Illinois that 57,000 tons produced in 1968.

Even though more corn was produced per acre in 1968 than in the 1940's, the efficiency with which crops used available fertilizer actually declined fivefold. Fertilizer's overuse has led to serious environmental problems, such as the addition of nitrates to water supplies. Nonetheless, synthetic fertilizers have made our agricultural productivity legendary.

Since the recent escalation of international petroleum prices, however, the cost of making fertilizer has increased 40 percent, and even at such high prices a fertilizer shortage of 500,000 tons existed here in 1974. The shortage may become even worse.

Modern agriculture has also become dependent on synthetic chemicals--mostly derived from fossil fuels--for pest and weed control. In primitive agriculture, and in diversified farming, pest control consists largely of planting multiple crops which will not be completely destroyed by pest infestations. Such methods are not practical in large-scale, or monoculture cropping, where one variety of wheat or corn may be planted in fields stretching many square miles. While the use of pesticides and herbicides has contributed greatly to the volume of production by minimizing losses, the environmental effects have been serious and much publicized. Ultimately, the oil crisis may force a return to less energy-intensive methods of pest control, even if environmental precautions don't.

Another high energy user in modern, mechanized agriculture is irrigation. A complex of dams and canals designed to bring water from northern California to the farmlands of the southern part of the state will cost $12 billion when completed--nearly $500 for each man, woman and child in California. The pumping requirements of the water project have been estimated at 13 billion kilowatt-hours of electricity per year. Since the net generation of electricity from the hydroelectric dams will amount to only five billion kilowatt-hours per year, the project will suffer an energy deficit of eight billion kilowatt-hours per year, a substantial part of the state's overall energy bill. Energy-intensive irrigation systems are being installed on a mammoth scale in other areas, including the Pacific Northwest.

All of this intensive use of mechanization and farm chemicals has transformed the substance and the look of the entire food system, as a trip to a mechanized farm graphically illustrates. In the lush Salinas Valley south of San Francisco, agriculture has become a major industry, replete with an army not of people but of field machines which plant seed, fertilize the soil, apply pesticides and mechanically harvest such crops as lettuce. Whereas ten years ago nitrogen fertilizer application of 300 pounds per acre to a crop would have seemed quite high, it is now common practice in the Salinas Valley to apply more than 1,000 pounds to each of two crops planted on each acre of land per year, or up to 2,500 pounds yearly. Mechanical harvesting enables many crops to be boxed in the field, trucked to a nearby depot, and then shipped--by truck or train--to various points across the United States.

Eric Hirst, of the Federal Energy Administration, found that the food system in 1963 consumed an average of 6.4 units of primary energy (mostly from fossil fuels) to deliver each unit of food energy to the consumer. In some cases, such as with processed fruits and vegetables, more than 15 units of fossil fuel energy were used to deliver each unit of food energy to the consumer. Today the ratio is even greater.

One of the basic ways that the American diet contributes to high energy use is the extensive consumption of animal protein, particularly beef. Frances Moore Lappe, in her book, *Diet for a Small Planet*, points out that an acre of cereal can produce five times as much protein as an acre devoted to meat production; legume crops (peas, beans) can produce ten times as much as meat; and leafy vegetables 20 times as much as meat. As food expert Dr. George Borgstrom of Michigan State University says: "The livestock of the rich world is in direct competition with the humans of the poor world." Dr. Borgstrom calculates that the difference in food calorie consumption between the rich nations and poor nations is much greater than is generally recognized. In the United States, the average daily calorie (kilocalorie, or large calorie) consumption of an adult is 3,300 food calories, but in India consumption is 1,990 calories. However, since meat consumption is so much lower in India, the grain fed to animals (which are then consumed by humans) represents only 763 additional calories, compared to a whopping 10,017 additional calories of grain fed to animals in the United States. Says Borgstrom: "The difference in calorie intake per capita per day between the United States and India is not, as generally assumed, 1,310 but rather 9,182 calories. This in itself reflects an awesome discrepancy which illuminates a much overlooked aspect of the food-and-people issue."

According to Dr. Herman Koenig, the director of Michigan State University's Ecosystem Design and Management Program, the production of beef cattle in the United States is too mechanized to be really efficient. Some feedlots in America are designed to feed tens of thousands of cattle at a time. The Monfort of Colorado, Inc., feedlots near Greeley process more than 100,000 cattle yearly in a highly automated, computer-controlled operation. Cattle arrive at the lots when they weigh from 700 to 800 pounds, are then fed in pens, and slaughtered five months later when they reach 1,100 to 1,200 pounds.

Corn shipped to the Monfort operation from company-owned elevators in the Midwest arrives in yellow torrents. The daily flaking and cooking of corn for Monfort cattle at the company's mills yields more cornflakes than the Kellogg corporation makes each day for human consumers.

Such gargantuan operations are wasteful of energy, according to Koenig, who says that cattle feedlots which have 200 to 300 head of cattle are the optimum size for efficient energy and resource use. On a regional and national scale we may have to think smaller to improve the economy and save energy. "One alternative we should begin to think of is the possibility of limiting the scale of mechanization to provide job opportunities. This carries with it the potential of generating an increased spatial distribution of people and processes to put us in better harmony with the natural environment. It might also relieve some social stresses."

Even the Department of Agriculture, which has done much to promote large-scale farming, has published several technical studies which confirm that small farms can be quite efficient. The department's Economic Research Service says that "the fully mechanized one-man farm, producing the maximum acreage of crops of which the man and his machines are capable, is generally a technically efficient farm. From the standpoint of costs per unit of production, this size farm captures most of the economics associated with size."

Nevertheless, small farms are disappearing daily from the American landscape while corporate farms have become the rule. The Tenneco corporation, for example, which has enormous assets in oil production, chemicals and ship-building, has moved into corporate farming in California and other western states under the motto: "Our goal in agriculture is integration from the seedling to the supermarket."

As American agriculture shifts noticeably from small farms using modest amounts of resources to factory farms and distribution systems gobbling limited energy resources, University of Wisconsin researchers John and Carol Steinhart say that "there has been no reduction in (agriculture and food labor) at all--only a change in what workers do. Yesterday's farmer is today's canner, tractor mechanic and fast food carhop." Bruce Hannon, of the University of Illinois Computation Center in Urbana, recently illustrated the energy use entailed in the packaging of food. The McDonald's restaurant chain used the equivalent of 12.7 million tons of coal in 1971 to feed its patrons. For each customer, that was the equivalent of 2.1 pounds of coal. Hannon points out that his objective was not to single out McDonald's for criticism, but to point out the waste inherent in the convenience-food life-style of contemporary America.

As much of the world faces famine today and in years to come, the waste of America's food and agriculture system stands out as a particularly sore thumb of affluence. The choices open to the food-rich nations (Canada, New Zealand, Australia and the United States) are either to export technology or export food.

"None of these (countries) is in a position to give grain away," say the Steinharts, "because each of them needs the foreign trade to avert ruinous balance of payments deficits. Can we then export energy-intensive agricultural methods instead?"

The historic answer to this question lies in the green revolution. Under the scientific direction of agronomists such as Dr. Norman Borlaug, yields of many strains of wheat, corn and rice were improved by the development of hybrids, and improved seeds were distributed widely in poor nations. To get high yields, however, the new seeds often require high rates of fertilization, pesticide use and mechanical irrigation. Thus, the green revolution has a dependency on fossil fuel--a resource in critically short supply, and available only at a high cost.

Dr. David Pimentel, an agriculture specialist at Cornell University, is pessimistic over the future of the green revolution. "Modern, intensive agricultural practices of the western world and those proposed by green revolution agriculture will not offer a solution for the world food problem....To feed a world population of 4 billion while employing modern intensive agriculture would require an energy equivalent of 1.2 billion gallons of fuel per day. If petroleum were the only source of fossil energy and if all petroleum reserves were used to feed the world population using intensive agriculture, known petroleum reserves would last a mere 29 years."

Another tragic by-product of the rise of energy-intensive agriculture is the fate of natural seed stocks, which were widely used only a few decades ago. Since the advent of "miracle" hybrid seeds, the older seeds have, in many cases, been lost through neglect--ending a genetic continuity of many millenia. Agricultural researchers are experiencing great difficulty in acquiring stocks of native seeds for preservation programs. According to a recent United Nations report on genetic resource, "the older diverse (crop) varieties...are sown no more; many of the wild relatives with which they maintained genetic interchange have been swept away."

The problem of genetic diversity is equally challenging--and frightening--in the advanced nations. The National Academy of Sciences published a major work on the genetic vulnerability of major crops which concluded that such vulnerability stems from genetic uniformity, and that some crops were highly susceptible. In 1970, a blight wiped out 15 percent of the corn, and the situation was corrected only when seed growers developed new seed which was not vulnerable to blight. But seed development is dependent on gentic "banks" which store thousands of varieties of native seed: if the seed is not available, then new varieties can't be developed.

There is a national seed storage facility in Fort Collins, Colorado, but funds are limited and the director of the facility, Dr. Louis Bass, fears that without sufficient funding the seed storage program will not be adequate to meet the challenge of genetic erosion. The consequences of the loss of native seed germ-plasm are staggering, when one thinks that within one short generation, human beings could throw away key evolutionary links in the food system--all in the name of progress.

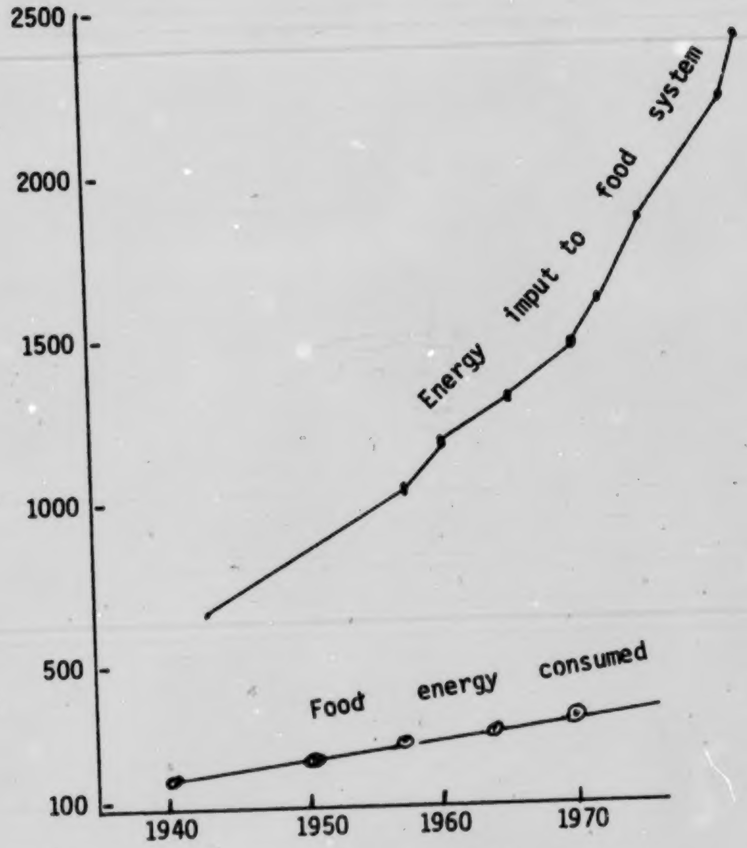
The alternatives to continuing the present system, which delivers each calorie of food to the consumer at the expense of 10 to 20 calories of fossil energy, include searching for better ways to use natural fertilizer, instead of depending on synthetic fertilizers. And, in fact, interest in the use of organic materials for fertilization is picking up--not just among home gardeners--but in major cities such as Chicago, which has undertaken a study of the potential use of sewage in conjunction with farming in nearby Illinois and northwestern Indiana.

Other ways to decrease energy use are to encourage the development of smaller, less energy-intensive farms; to use farming methods based on diversity and to plant legumes such as soybeans, which add nitrogen to the soil and minimize the need for nitrogen fertilizers; and to use biological pest-control methods as substitutes for the intensive use of chemicals. In addition, hand spraying of pesticides and herbicides, rather than application by large machines and airplanes, can save energy in large doeses. Diversity of this sort could be the starting point for the development of a sound, efficient agricultural system.

Such a system would also make better use of natural energy sources such as solar power. Solar crop-drying techniques are under development in many states, including Indiana, where 60 million gallons of liquid petroleum fuel and 1.5 billion cubic feet of natural gas are now used yearly to dry the corn crop. Windmills can be used to pump water for agricultural irrigation, rather than fossil-powered electrical pumps. Methane gas can be made on the farm from various organic substances, including animal wastes.

The creation of such an agricultural system, with the concomitant result of better land use and a more wide-spread population, will not take place overnight. However, it will be necessary in the energy and resource-short years to come. As the English economist Ernst Friedrich Schumacher has written: "The challenge presented by the energy problem is one of developing a new life-style--a development which logically and inevitably must begin with a change of man's relation to the soil, of which he is a product and which alone sustains his life."

Graph I


2500
2000
1500
1000
500
100
1940
1950
1960
1970
Energy imput to food system
Food energy consumed

Graph II

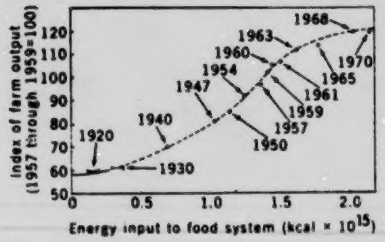


Fig. 2. Farm output as a function of energy input to the U.S. food system, 1920 through 1970.

Graph III

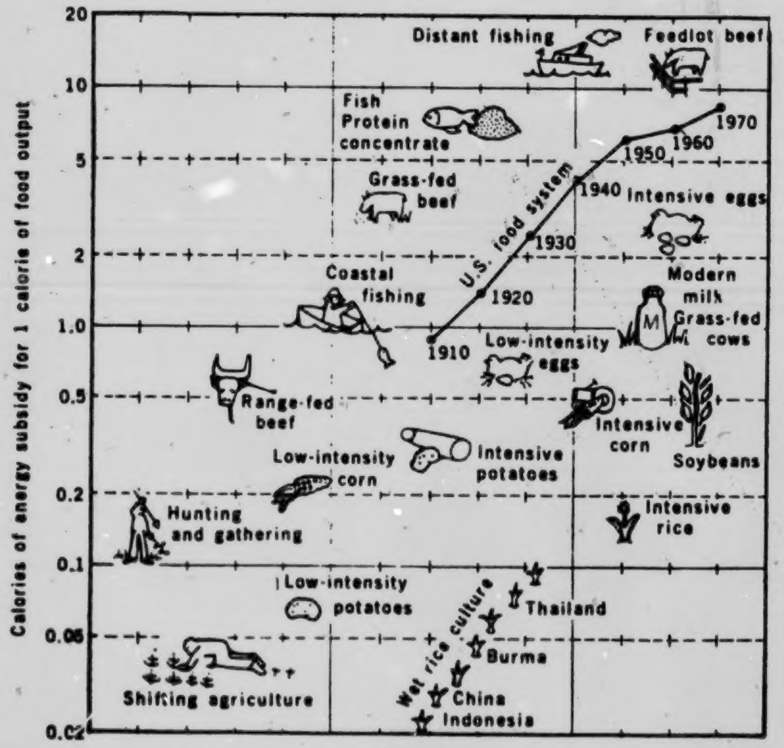


Fig. 5. Energy subsidies for various food crops. The energy history of the U.S. food system is shown for comparison. [Source of data: (*31*)]

title: "The Costs Of Reducing Energy Consumption"

uses

concept: There are many ways to conserve energy.

objective: Given the opportunity to participate in a classroom brainstorming activity, the student will be able to find ways to reduce energy consumption at home and the "costs" of that reduction.

time: 2-3 45 minute class periods

subject matter area: Science, Social Science

grade: 10-12

implementation:

Activity:

1. Collect guides on ways to save energy from your local power companies. (The teacher could have a supply of these on hand before implementing the lesson.)
2. Have the students bring in a copy of their home utility bills covering a specified time period. Graph and compare.
3. Using the guides from local power companies on ways to save energy, brainstorm a list of ways to reduce utility bills.
4. Determine which of the listed items would have the greatest impact on fuel consumption.
5. Which method to reduce energy consumption would give the greatest results with the least environmental impact?
6. Which method(s) to reduce energy consumption would be least expensive?
7. (Optional) With family cooperation, implement some of the suggestions. Graph and compare utility bills one month later.

materials:

Helpful: Local power companies' guides on ways to save energy.

activity no. 10

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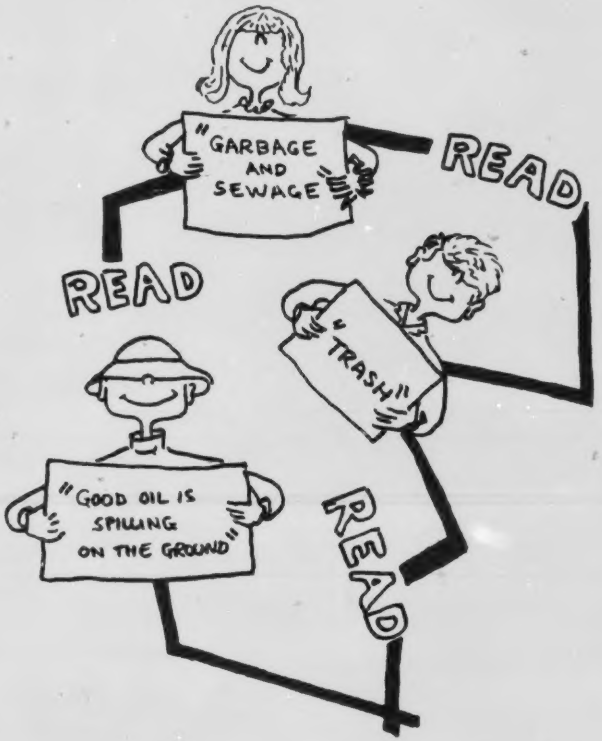
implementation:

SUGGESTED CAREER EDUCATION ACTIVITY:

Given an opportunity to hear a speaker from a local utilities company discuss the future of employment in public utilities, the student will be able to identify several occupations for further exploration which are related to the energy field.



materials:

SUGGESTED ASSESSMENT PROCEDURE:

Given the opportunity to discuss and suggest methods of reduction of home energy consumption, the student will be able to identify which method of reducing energy consumption would give the greatest results with the least environmental impact.

Developed by: Ted Parker
Beaverton School Dist.
Beaverton, OR

title: "Things I Like To Do"

uses

concept: Every decision made involving energy affects standards of living.

objective: Given the opportunity to make a list of things they like to do, the students will be able to examine the items and determine a value for each.

time: 1 - 30 minute session-depending on grade level

subject matter area: Social studies (values)

grade: 10-12

implementation: Ask the student to make the following chart on a sheet of paper:

Things I like to do	$	E	e	F&/or M	"10"	Date
1.						
2.						
3.						
4.						
5.						

Ask the students to make a list of 5-10 things they like to do.

1. Place a $ sign by any item which costs more than $3.00 each time to do it.
2. Put an "E" in front of any item which uses a lot of mechanical energy to perform.
3. Put a small "e" next to the items that require a little mechanical energy to perform.
4. Using the code letters "F" and "M", record which of the items on your list you think your father or mother might have had on their lists if they had been asked to make one at YOUR age. (F= Father and M= Mother)

materials:

Paper
Pencil

"The Nightmare Life Without Fuel," Isaac Asimov, Time, April 25, 1977.

activity no. 11

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implementation:

(continued)

5. Place a number "10" in front of any item which you think would not be on your list 10 years from now.
6. Finally, go down through your list and place near each item the date when you did it last.

Discussion: Teacher should ask students for the responses they put down on each item. Ask why?

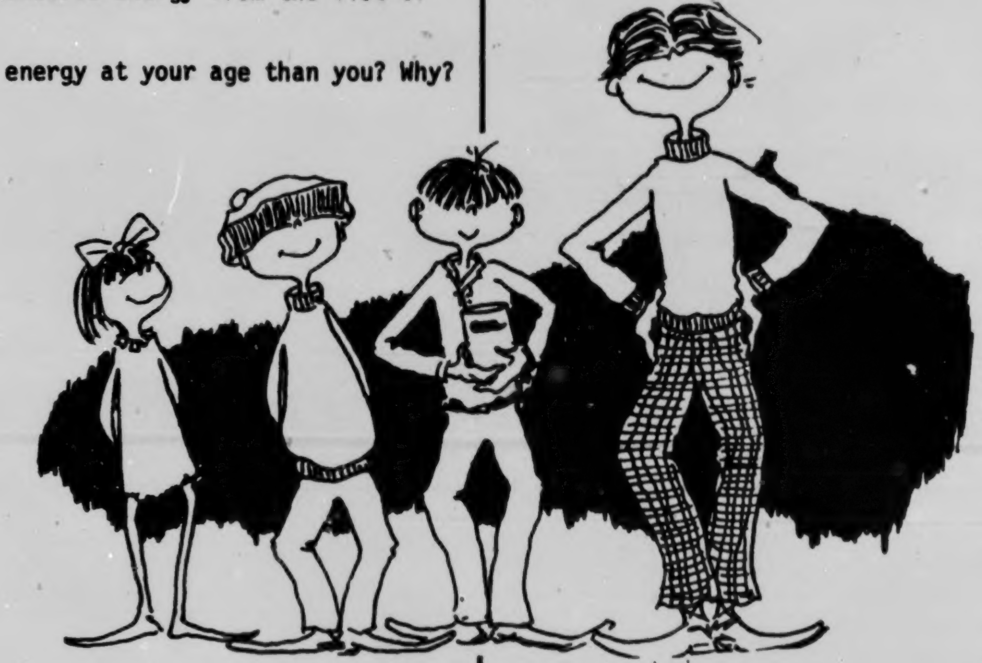
*Key questions-

1. What does your list tell you about the things you like to do?
2. List ways that you could conserve energy from the list of things you like to do.
3. Did your parents use less energy at your age than you? Why?

materials:

SUGGESTED ASSESSMENT PROCEDURE:

Given the opportunity, the student will be able to make a value judgment by making a verbal or written statement about the things he/she likes to do.



title: "Leisure Time Activities"

uses

concept: Every decision made involving energy affects standards of living.

objective: Given the opportunity to participate in a values clarification exercise, the student will be able to become more aware of the relationship between standard of living and energy use.

time: 1-2 30 minute sessions-depending on grade lev.

subject matter area: Social Studies (values)

grade: 10-12

implementation:

PROCEDURES:

1. Ask each student to make a list of five leisure time activities s/he enjoys doing.
2. Rank in order each activity from the most important to the least important.
3. Next to each item place a $ (dollar sign) if the activity costs money each time it is performed.
4. For each item, assign a mechanical energy point value. Give the activity points according to this scale:
    3 points if a major amount of energy is used.
    2 points if a moderate amount of energy is used.
    1 point if very little energy is used.
    0 points if no artificial energy source is used.
5. For each item give :
    3 points if the activity is performed a lot.
    2 points if performed occasionally.
    1 point if performed seldom.
    0 points if never done.
6. Add an additional point for each activity with a $ sign.
7. Multiply the Energy Consumption points by the points assigned to the Amount of Use. Indicate this in a column labeled Total Value.

materials:

Copies of a chart like the sample chart attached
Paper
Pencil

activity no. 12

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implementation:

(continued) 8. Assume that a severe energy crisis now exists, and that all people must conserve as much energy as possible. Cut back your leisure time activities so that your point value total is reduced by at least 50%!

9. Retotal the Total Value points after making reductions in the Amount of Use.

Class Discussion for Follow-Up:

1. Are you willing to reduce by 50%? Why or why not?
2. How did you conserve energy? Which items did you reduce?
3. Does your priority ranking affect your decisions? If so, how?
4. Does the $ value have any effect on energy usage?
5. What types of activities can we do that are fun and do not require much use of artifical energy sources?

materials:

SUGGESTED ASSESSMENT PROCEDURE:

Given the opportunity, the student will be able to list ways s/he can conserve energy in leisure time activities.

Developed by: Dan Grimes
EME

Revised by: Jon Thompson
EME

ILLUSTRATION OF ACTIVITY - FOR TEACHER USE ONLY

ACTIVITY	RANKING	$	ENERGY CONSUMPTION	AMOUNT OF USE		TOTAL VALUE	
				BEFORE	AFTER	BEFORE	AFTER
Water skiing	2	$	3	2	1	7	4
Guitar	1	0	0	3	3	0	0
Sailing	4	$	1	2	1	3	2
Motorcycle riding	5	$	1	3	2	4	3
Snow skiing	3	$	2	2	0	5	0
				TOTAL POINTS:		19	9

Before = Before making a reduction in use.

After = After making activity use reductions.

Note: A reduction of more than 50%.

ENERGY CONSUMPTION (Mechanical)

Points	Amount
3	If a major amount of energy is used
2	If a moderate amount of energy is used
1	If very little energy is used
0	If no energy is used

AMOUNT OF USE

Points	Amount
3	If done a lot
2	If done occasionally
1	If done seldom
0	If never done

TOTAL POINT VALUE

To obtain the total point value, multiply the number of points assigned to Energy Consumption by the number of points of the Amount of Use. Add 1 point for each activity with a $ sign. (Remember, zero times any number equals zero.)

Activity	Energy Consumption		Amount of Use	$		Total Value
Flying	3	X	2	+ 1	⇒	7

USES

CONVERSIONS OF ENERGY

GOAL:

IT IS ESSENTIAL THAT EACH PERSON KNOW THAT ENERGY CAN BE CONVERTED FROM ONE FORM TO ANOTHER.

ACTIVITY
DESCRIPTION PAGE
CONVERSIONS (10-12)

Goal: It is essential that each person know that energy can be converted from one form to another.

Concept: There are natural and artificial energy conversion systems subject to natural laws.

Activity #1 "Trends in Nature"
Grade level 10-12
Science

Given the opportunity to gather the necessary background information, the student will be able to describe energy conversion using the terms or ideas in the First and Second Laws of Thermodynamics.

Activity #2 "Mouse Study"
Grade level 10-12
Science

Given the opportunity to complete an experiment in energy conversion, the student will be able to compute and discuss the energy flow and uses in a mouse.

Activity #3 "Accommodation of Waste Products"
Grade level 10-12
Language Arts, Social Science

Given the opportunity to complete a small group research activity, the student will be able to identify in writing support for the statement, "The waste products from artificial energy conversion systems are more difficult for the natural environment to accommodate than waste from natural energy conversion systems."

Concept: All conversion processes use energy or lose heat energy.

Activity #4 "Heat Conversion and Transfer"
Grade level 10-12
Science

Given the opportunity to complete an experiment, the student will be able to understand that heat can be converted and transferred from one place to another by molecular motion.

ACTIVITY
DESCRIPTION PAGE
CONVERSIONS (10-12) (continued)

Concept:	There is a variety of units of measure for the efficiency and energy conversion.
Activity #5	"Efficiency and Energy Conversion" Grade level 10-12 Science, Mathematics Given the opportunity to understand efficiency equations, the student will be able to apply efficiency equations to specific heat producing energy conversions.
Concept:	There are ethical, legal, aesthetic, social, political, economic, biological, and physical benefits and problems associated with energy conversion.
Activity #6	"A New Law" Grade level 10-12 Social Science Given the opportunity to identify current energy problems, the student will be able to participate in the design and test the acceptability of a proposed law to deal with a current energy problem.
Activity #7	"Benefits and Problems of Conversion Technology" Grade level 10-12 All Subject Matter Areas Given the opportunity to gather the necessary background information, the student will be able to identify ways that energy conversions may benefit a community.
Concept:	History can be described in terms of the level of energy conversion technology.
Activity #8	"Technology and Transportation" Grade level 10-12 Social Science Given the opportunity to evaluate the changes in transportation modes, the student will be able to describe the implications of technological change on transportation.

title: "Trends In Nature"

conversion

concept: There are natural and artificial energy conversion systems subject to natural laws.

objective: Given the opportunity to gather the necessary background information, the student will be able to describe energy conversion using the terms or ideas in the First and Second Laws of Thermodynamics.

time: Variable

subject matter area: Science

grade: 10-12

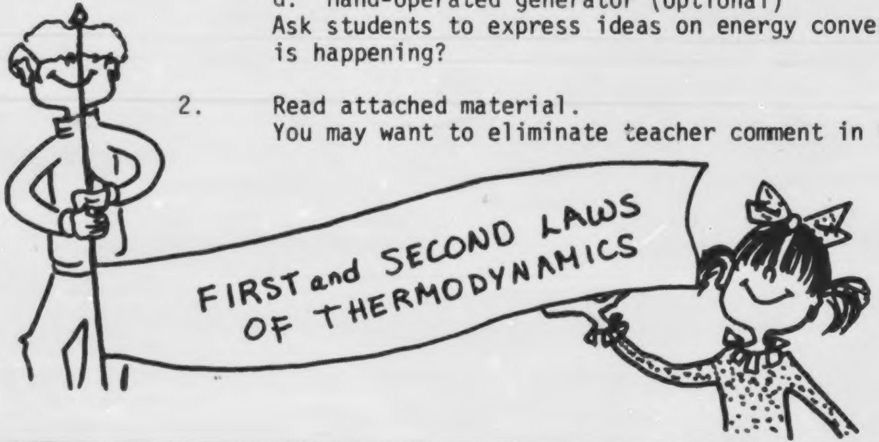
implementation:

Activity: I. Demonstration (you may try one of several) showing energy conversions.

- a. Hand-operated flashlight
- b. Light bulb
    - mostly heat
    - light
- c. Heating water
- d. Hand-operated generator (optional)

Ask students to express ideas on energy conversion. What is happening?

2. Read attached material.
You may want to eliminate teacher comment in the margin.


FIRST and SECOND LAWS OF THERMODYNAMICS

materials:

Light bulb
Rubber bands
Heat source
Weight
Indicator arm
see sketch

Article: "Trends In Nature" (attached)

Film: "You Can't Go Back"
Elementary Penguin Productions
1043-3 South Westmoreland
Los Angeles, CA 90006

activity no. 1

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implementation:

SUGGESTED CAREER EDUCATION ACTIVITY:

Given an opportunity to complete the necessary research, the student will be able to identify a proposed "new" process or application of a process to develop energy conversion systems, and write a paper discussing the changes in, or creation of, occupations which might result from the "new" processes, and the implications these changes might have on the educational and training plans of students.

materials:

SUGGESTED ASSESSMENT PROCEDURE:

Given the opportunity to investigate energy conversion through demonstration, reading, and experiments, the student will be able to describe and give examples of the First and Second Laws of Thermodynamics, and indicate what the trend towards disorder implies by using written, oral, or pictorial means.

Developed by: Ted Parker
Beaverton School Dist.
Beaverton, OR

A. UTILIZING HEAT

Energy is readily convertible from one of its forms to another. Whenever careful measurements are made, however, a basic rule has always been observed to operate: no more energy can be obtained from a transformation than was put into the process from all sources. This is the First Law of Thermodynamics--the principle of conservation of energy. How good a job can we do in converting one form of energy to another desired form? In particular, since so much of our modern industrial world depends on producing mechanical energy (to drive automobiles, turn electrical generators, etc.) from heat energy (produced by the burning of oil, in nuclear reactors, etc.), it is particularly appropriate to ask how efficiently this sort of transformation can be made.

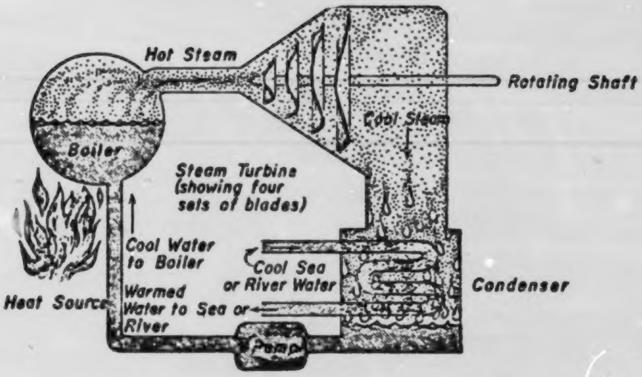
A.1. - A HEAT ENGINE

There has been a great deal of interest recently in the development of steam engines for automobiles. As information on this begins to appear in popular magazines and newspapers it may be of interest to keep abreast of the technicalities involved, such as the condensing systems used, advantages over internal combustion engines, and limitations of such engines.

Let us briefly consider the machinery which is widely used in ships and power plants to generate mechanical energy. The central device, called a steam turbine, is a sort of glorified rotating fan which turns whenever steam is forced past its many blades. Steam is produced in a boiler which is heated by coal, oil, or a nuclear reactor. Another essential device in this sort of power system is the condenser. Its function is to cool down and thus liquify the steam after it leaves the turbine

Teacher may want to show more detailed set-ups rather than figure A.1.

blades so that (a) the water may be returned to the boiler and reused, and (b) space may be created at the exit side of the turbine for the continuously produced volumes of steam. The steam turbine engine is sketched below.



Steam Turbine Showing Four Sets of Blades

Figure A.1

In old fashioned engines, such as those used on old railroad locomotives you have seen on TV, steam was not recirculated to the boiler via a condenser, but was simply exhausted to the air. This is rarely done today for several reasons. The water required in modern boilers must be very, very pure and hence cannot be simply thrown away and wasted. Pure water is expensive. Secondly, as we shall soon see, the cooler we can make the exhausted steam the more mechanical energy we can produce from a given quantity of heat.

Show PSSC Film "Energy & Work," 30 minutes, from Modern Learning Aids.

A.2. - WHERE THE HEAT GOES

There is a major thing to be noted about the steam power system described above. Although heat is taken in and converted to mechanical energy, only part of it is so converted. A portion of the heat is extracted in the condenser and thrown away, usually into some river or the ocean. This wastage of heat is unavoidable. Even if we built the most refined engines with the smoothest, frictionless moving parts, and even if we were to perfectly insulate all incidental losses of heat by radiation or conduction, in order for mechanical energy to be produced some heat would necessarily be lost. No engine has ever been built which does not share this characteristic. In the old fashioned steam engine, heat is lost into the air via the exhausted steam.

Can you think of the ways heat is lost by the gasoline engine in an automobile? Not all the heat contained in fuel (chemical or nuclear) is available for use by man; some necessarily goes into heating the environment.

Auto engine: Hot exhaust gases, radiation from hot surfaces, convection, and radiation from radiator (or from cooling fins on air cooled engines), frictionally produced heat in bearings, etc. Also mechanical energy goes to essential engine auxiliaries such as fuel, oil, and water pumps and this ultimately is reduced to heat.

B. - THE SECOND LAW OF THERMODYNAMICS

The law of conservation of energy itself places no serious restriction on man since there is actually plenty of energy around. For instance, the water in the ocean contains fantastic amounts of energy in the form of ran-

At this point some teachers like to play the Flanders and Swann selection "Thermodynamics" from the Angel record, "At the Drop of Another Hat." Unfortunately the lyrics use the term "work" which has been avoided in this material. However, it might be explained that "work" is for our purposes what we have called "mechanical energy."

There are several alternative but logically equivalent statements of the Second Law of Thermodynamics:

(a) Heat cannot be completely converted to work (the ship mentioned here could not work);

(b) Heat cannot of itself flow from a cooler to a hotter body (a refrigerator is needed);

(c) Entropy of a closed system increases (net order is reduced).

These statements also imply a limitation on the efficiency of engines.

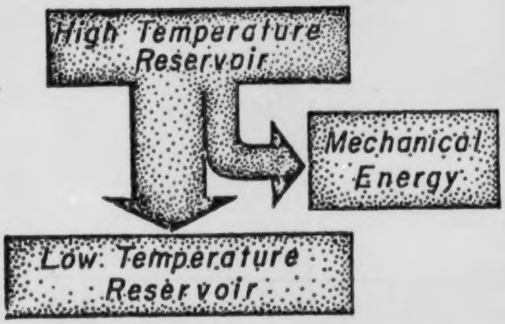
If Q_1 is taken from the high temperature reservoir and Q_2 is lost

$$\text{Efficiency} = \frac{Q_1 - Q_2}{Q_1}$$

dom molecular motion. Why is it that no one extracts this energy for doing useful work? It would not be inconsistent with the law of conservation of energy to extract heat (thermal) energy from the ocean and, say, run a sawmill aboard a ship. Why, in fact, shouldn't a ship be able to get power to cruise the oceans by gulping in ocean water at the bow, extracting a net amount of thermal energy and dumping cakes of frozen seawater out the stern?

Such a ship would operate in consistency with the law of conservation of energy. However, there is a second law which prohibits such a machine. It states that all machines which convert thermal energy to work (heat engines) must have two reservoirs at different temperatures. The engine can take heat from the reservoir at the higher temperature (source) and convert only some of the heat to mechanical energy; the rest of the heat will be expelled into the low temperature reservoir (sink). This is schematically illustrated by the following diagram.

Figure B.1



The percentage of the heat taken from the high temperature reservoir which is converted to mechanical energy is called the efficiency. In a steam turbine system, what is the high temperature reservoir? What is the low temperature reservoir?

C. A MACHINE THAT ALMOST WORKED

One could operate a machine which utilized the temperature difference between the warm surface waters and the cold deeper waters of the tropical ocean. Such a machine, designed and built by Georges Claude, is described in the interesting paperback book Engineer's Dreams by Willey Ley (Viking-Explorer Books, the Viking Press, New York). However, Claude had a severe limitation since the second law relates the maximum efficiency of the heat engine to the temperature difference between source and sink. When this difference is small (as it is between a surface temperature of 27^{0}C and 5^{0}C for deeper, tropical ocean waters), the law states that the efficiency will be low. In practice, when incidental losses due to friction, heat loss, and other losses were taken into account, his design fell very much short of the maximum possible efficiency stated by the second law. In fact, the net efficiency of Claude's machine was near zero. Discouraged, he sank all his machinery in the ocean; he was

Note: Article in Popular Science "How They'll Pump Energy From the Sea" Popular Science, March, 1971, Vol. 198, #3, p.38.

If the only heat loss is the heat flowing to the low temperature reservoir and if the engine is built to operate on an ideal thermodynamic cycle (Carnot engine) the efficiency would still be limited by the temperatures T_1 and T_2 of the reservoirs.

$$\text{Max. efficiency} = \frac{T_1 - T_2}{T_1}$$

In this formula the temperatures are in absolute degrees. Real engines can only approach ideal ones and have incidental losses besides.

an idealist. If his machinery had worked only a little better, he would really have harnessed an unusual heat source.

D. - ORDER AND DISORDER

We have seen that it is absolutely necessary that some heat be lost to a cold region in order for a machine to produce usable mechanical energy. This is an inexorable consequence of the Second Law. We may look at this Law from a somewhat different but perhaps even more revealing point of view, as follows. Heat may be thought of as "disordered energy"--it manifests itself in the chaotic motion of individual molecules and atoms cannot be predicted, only gross averages of many of them. The colder a body, the less disorder it represents. On the other hand mechanical energy (work) represents "ordered energy." A rotating wheel can be described relatively simply, and each of its parts follows a predictable path from moment to moment. Stated in a different form, the Second Law says that total order created by any actual engine will be less than the total disorder. In other words, useful work will be generated only at the expense of a net amount of disorder being created. An engine takes heat from a high temperature reservoir, thereby cooling it down somewhat and hence making it more ordered. But it more than makes up for this by heating up the low temperature reservoir. Being relatively cool to begin with, this reservoir becomes relatively more disordered upon being heated.

An excellent discussion of entropy may be found in "The Laws of Disorder" by George Porter, *Chemistry* Reprint #58. Reprints cost $1.00 for the first copy and 50¢ for each additional copy. Order from: Reprint Dept., Chemistry, 1155 Sixteenth St., N.W. Washington, D.C. 20036

D.1. - THE TREND TOWARDS DISORDER AND WHAT WE MAY OR MAY NOT DO ABOUT IT

Left to themselves, almost all things tend towards disorder. This is the operation of the Second Law. For instance, when a hot body and a cold body touch each other, the heat always flows from hot to cold, and the net result is more disorder. For example let's do a mental experiment with bromine in sealed glass tubes. In the gaseous state the bromine atoms always spread throughout the tubes so that their positions become less localized; the system becomes less ordered. The bromine atoms could never of themselves collect neatly in the end of the tubes. the only way this can be done is by cooling them down; but as we shall now show, this cooling process is not inconsistent with the second law.

D.2 - REFRIGERATORS: DO THEY BUCK THE TREND?

A machine for cooling things down and thus producing some order (such as assembling water molecules into ice) is called a refrigerator. Below is a schematic diagram of the energy flow of a household refrigerator system. Notice that it ultimately takes some sort of engine to operate a refrigerator. It is indeed true that by transferring heat from a cold place to a warm place the refrigerator creates some order (for instance, water turns into ice cubes). But for this to happen, heat is transferred in some power plant from a high temperature place to a low temperature place. According to the second law, the net result will be an increased amount of disorder. Burning of fuel to produce heat in the power plant (i.e., releasing of chemical energy by breaking up ordered arrays of atoms in oil, for instance), more than makes up for the taking of heat away from the freezing water. A general way of expressing this is to say that localized order is produced only at the expense of order in the environment.

A hydroelectric power plant is a more subtle situation. The sun's heat cannot entirely be converted to potential energy of raised water. Some goes to warming the oceans (which ultimately radiate away heat to cool outer space). Even the potential energy of the water is not entirely converted to electric power. Some is converted to heat in the churning water below the dam.

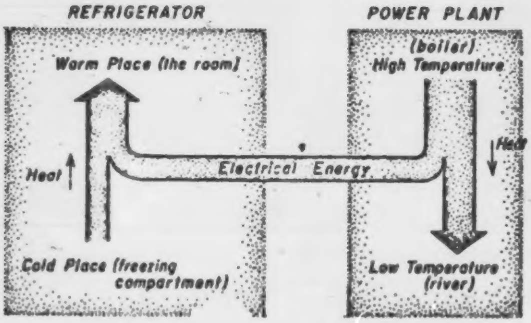


Figure D1

Some types of rubber bands seem to work better than others.

Materials and Equipment

Large flat rubber bands, 1 for each student.

"Heat Runs Amazing Rubber Band Motors," Popular Science, Jan. 1972, Vol. 200, No. 1, p.95. Gives directions on how to build a rubber band motor and a simple demonstration.

Chemical fuel is broken down by the body in order to supply the mechanical energy to stretch the rubber.

The boxes with the words "elongated band" and "normal length band" are not meant to show the comparative sizes or lengths of the band when it is stretched and then unstretched.

D.3. - Experiment: A RUBBER BAND REFRIGERATOR

Stretch a larger size rubber band (1/4 inch or more flat width) to a length at which it begins to strongly resist additional pulling. Hold it in this position for approximately 1/2 minute, then quickly return it to its unstretched length. You will note that the rubber is now cooler than it was before you stretched it. (A sensitive place to test the temperature is the area just above your upper lip.) A tiny amount of heat has been removed from the rubber band and placed into the room. This is a one-step refrigeration process.

The cooled unstretched rubber band is a little more ordered than the room temperature unstretched rubber band. Has there been a net increase in order? Consider the effort required to stretch the band.

The process can be diagrammed as follows:

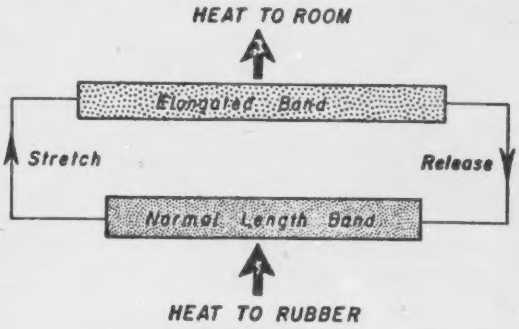


Figure D.2

This process also has a relationship to order and disorder. Rubber is made up of very long but intertangled helical molecules. When the rubber band is stretched the molecules are more or less lined up with one another, that is, they assume a more ordered configuration. When the band is released and allowed to resume its normal shape, heat is required to scramble the molecules again; the temperature drops, and this heat flows in from your upper lip, for instance.

E. - LIVING THINGS AND THE TREND TOWARDS DISORDER

As far as scientists have been able to tell, all living things, from the tiniest microbe to the largest whale, are made up of atoms and molecules. And you too--despite all the wonderful things you can do such as thinking and feeling and walking and laughing--are a collection of chemicals arranged in a complex and special way. What is the difference between you and some other complex collection of chemicals? If you were not alive, eventually your body chemicals would break down into simpler collections of atoms; others would react with one another forming different substances until they were used up; ultimately all change and motion would not be noticeable. This system of chemicals would become an inert lump of matter. As the Second Law requires, this final decayed state would be more disordered than the original one.

These ideas are adapted from Edwin Schrodinger as given in his highly readable essay "What is Life" available in paperback (CAM 397, Cambridge 1967). In shortened form it is given in the collection "The Mystery of the Matter," Louis B. Young, Editor (Oxford University Press, New York 1965).

What then is the characteristic feature of life? It is this: that a living thing, being a wondrously complex and highly ordered collection of molecules, maintains itself against the inexorable trend toward disorder that marks the fate of other complex collections when left to themselves. It does this by eating, drinking, breathing, and continuous rebuilding of its body parts out of the substances it ingests. But what of the world outside a living organism, the environment upon which it depends for life? In total, the environment is very much degraded. Higher animals, for instance, utilize foods which store their energy in the chemical combinations of relatively highly ordered molecules. The energy is released in degraded form as heat, waste products, and motion (which ultimately becomes heat). Even green plants, which utilize radiant energy to build up complicated molecules from simpler ones, cannot overcome the dictates of the second law. Only a portion of the energy in sunlight is converted into chemical energy. The rest ultimately becomes heat.

The living organism maintains its complexity and continues to grow and perpetuate itself as long as it has a source of energy--the sun in the case of green plants, animal or vegetable tissue in the case of animals. It takes in some energy and it rejects some; its wondrous "local order" is maintained only at the expense of order in the environment.

Exercises for Home, Desk, and Lab (HDL)

(1) What does the word "efficiency" mean to you?

(2) If the power input of an electrical motor was 600 watts and the power output was 400 watts, what would you say the efficiency of the motor was?

(3) The water underneath the arctic ice has a temperature of near $0^{\circ}C$, whereas the air above the ice may have a temperature near $-40^{\circ}C$. Could one use thermal energy in the sea water of the arctic for running a heat engine?

(4) A mathematical formula for the maximum possible efficiency of a heat engine is

$$m = \frac{t_1 - t_2}{t_1 + 273^{\circ}}$$

Here t_1 is the temperature of the source in $^{\circ}C$, t_2 is the temperature of the sink in $^{\circ}C$, and m is the maximum possible efficiency. What was the maximum possible efficiency of Georges Claude's heat engine? In practice, the efficiency of his machine was less than m.

(5) a. What is the maximum possible efficiency of the heat engine described in problem (3) ?

b. What would m be (using the formula in problem 4) if t_2 were -273° C? We are not making any statements as to whether or not it is possible to attain that temperature.

(6) Why is so much attention given the "fuel cell"? It has not been discussed here, but you may have learned about it in the newspapers, on TV, or in popular magazines.

(2) 2/3 or 0.67 or 67%. Power is a measure of rated energy usage. Watts are joules per second. Thus wattage is a term not necessarily restricted to electrical situations.

(3) Yes. Since the air is colder, the air can be used as a heat sink.

(4) The absolute (Kelvin) scale of temperature is given by $T = t+273$. Absolute zero is thus either $T = 0$ or $t = -273^{\circ}C$

If $t_1 = 27^{\circ}$ C

and $t_2 = 5^{\circ}$ C

$$\frac{27 - 5}{27 + 273} = \frac{22}{300} = 7\%$$

(5) a. If the engine were close to an ideal engine, m = 15%.

b. m = 100%

(6) The fuel cell is not a heat engine; it converts the chemical energy of the fuel directly into electrical energy. Thus, it does not have the restriction on the maximum possible efficiency that a heat engine has.

(7)

$$m = \frac{t_1 - t_2}{t_1 + 273^{\circ}} =$$

$$\frac{1500^{\circ}C - 22^{\circ}C}{1500^{\circ}C + 273^{\circ}C} =$$

$$\frac{1478}{1773} = 83\%$$

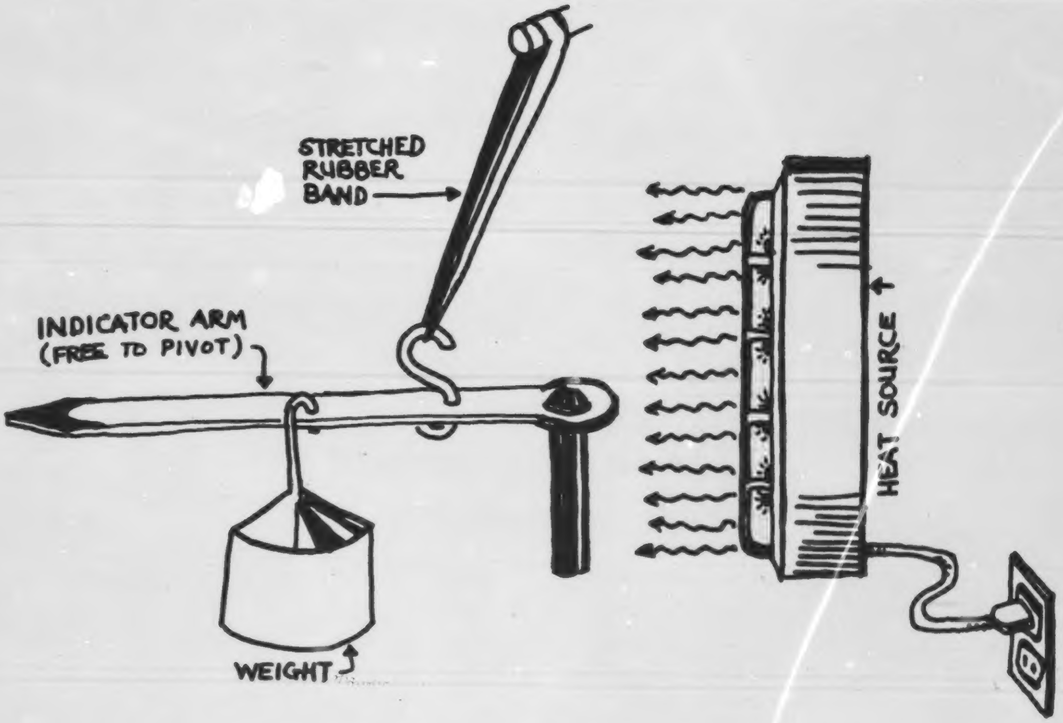
(If room temp. = 22°C.)

Cooling would likewise produce a temperature difference.

(7) A thermocouple is an energy converter which operates between two temperatures. In the one you used in Chapter III these were the temperatures of the flame and room temperature. A bunsen burner has maximum temperature of about 1500°C. What maximum efficiency of heat to electrical conversion would you expect from this heat source? Do you see now why cooling the junction also produced electricity? Notice that no current flowed when the entire apparatus was at room temperature.

(8) Use the library to look up the actual operating efficiencies of various engines such as steam engines, internal combustion engines (gasoline and diesel), etc. Encyclopedia articles may be a good place to start.

A RUBBER BAND REFRIGERATOR



title: "Mouse Study"

conversion

concept: There are natural and artificial energy conversion systems subject to natural laws.

objective: Given the opportunity to complete an experiment in energy conversion, the student will be able to compute and discuss the energy flow and uses in a mouse.

time: Variable (Not less than 8-10 45 minute class periods for entire activity)

subject matter area: Science

grade: 10-12

implementation:

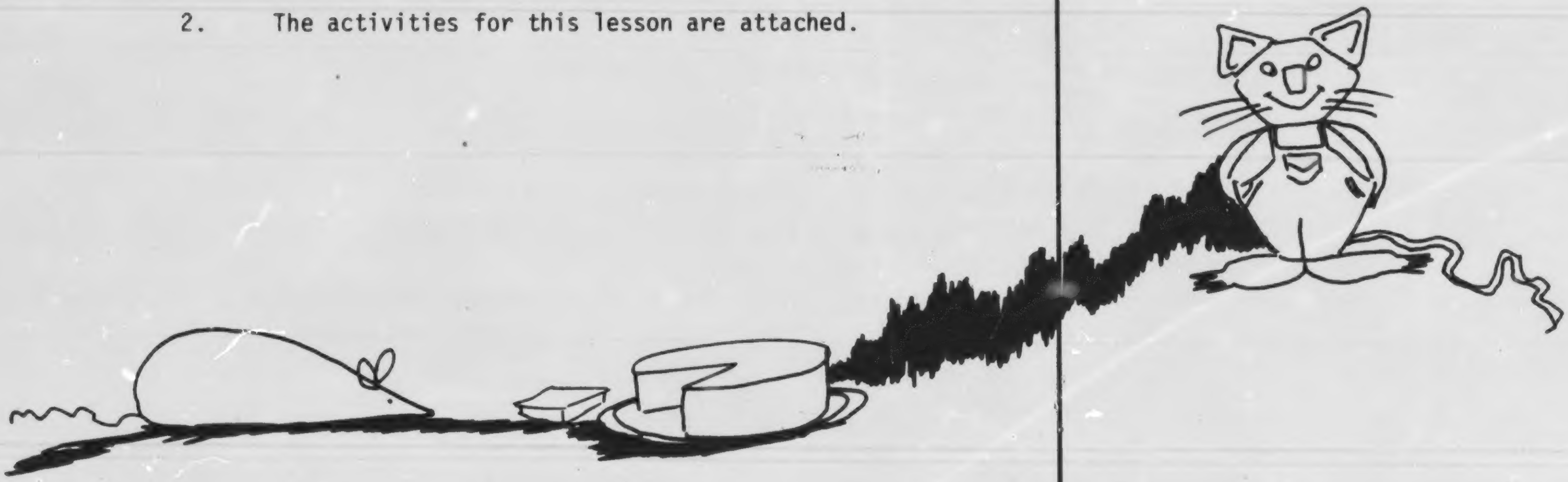
NOTE TO TEACHER:

1. RATIONALE: In this lesson you will discover how a typical animal uses its food energy. This food energy flows through all food chains being passed on from one feeding level to the next.

2. The activities for this lesson are attached.

materials:

The materials needed are included in the attached activity section.



activity no. 2

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Activity No. 2 (page 2)

implementation:

SUGGESTED CAREER EDUCATION ACTIVITY:

Given the opportunity to explore a number of occupations in the area of natural science, the student will be able to select an occupation of interest and describe the work performed in the selected occupation.

materials:

SUGGESTED ASSESSMENT PROCEDURE:

Given the opportunity to complete a packet of activities on how a typical animal uses its food energy, the student will be able to compute and discuss the energy flow and uses in a mouse.

Developed by:	Ted Parker Dave Bates Beaverton School Dist. Beaverton, OR

Activity: 1. Animal Energetics. What happens to the energy in the food you eat? Where does it go, and what does it become? Since it would be difficult to study you, we will investigate a typical mammal, the mouse, to learn what probably happens with humans.

a. First, you should carefully measure the weight of all the food which the mouse eats each day. What happens to the food eaten? Can the mouse digest all of its food? If not, what becomes of this unused food? Can you measure it?

b. The rest of the food and food energy is absorbed into the body of the mouse. This food energy must go somewhere. It does not simply disappear. Can you guess where it goes? Can you measure it?

c. Materials needed:
- 1 plastic beaker with top
- 1 mouse, small
- 1 cage with top
- 1 glass tube with plastic tubing attached or water bottle
- 1 clamp
- 1 scale, weighing to 0.1 g
- 1 pair of tweezers
- 2 petri dishes
- 1 roll of masking tape
- Drying equipment (oven, hot plate, heat lamp, etc.) if available
- Food supply - dry, large pellets
- Data sheet
- Wire screen
- Cedar shavings "feathers"

2. To study the energetics of a mouse, follow this procedure:

a. Set up a cage with a top so that the mouse cannot jump out.

b. Set up a water source for the mouse using a glass tube and plastic tubing with a clamp or a water bottle.

Activity:
(Continued)

c. Weigh the mouse and record the data to the nearest 0.1 g.

d. When doing this activity, be sure that the mouse has some water, but that the water cannot drip on the food, feces or food scraps. Always use dry food for feeding the mouse and be sure that some food is always in the cage.

e. Mass each of your adult mice daily.

f. Mass the total litter of pups (if over one week of age) daily.

g. Mass the food daily and determine consumption per day.

h. Determine the volume of water consumed per day. If you have a leaking water bottle, see your instructor. (NOTE: "e" through "h" must be conducted a minimum of 5 consecutive school days.

i. Next, determine the fecal (waste) mass for at least one entire 24 hour period. To do this part, remove all of the cedar shavings, clean the tray and replace with a pre-massed paper towel. After 24 hours, determine the mass of the feces. A wire screen placed over the bottom of the cage will keep the mouse from ripping up the paper towel.

j. The next task is to determine the urine output. Evaporation is a critical problem here. The procedure for this part will be to take a pre-massed dry paper towel and place on the bottom of the cage. Do this for a 6 hour period of time

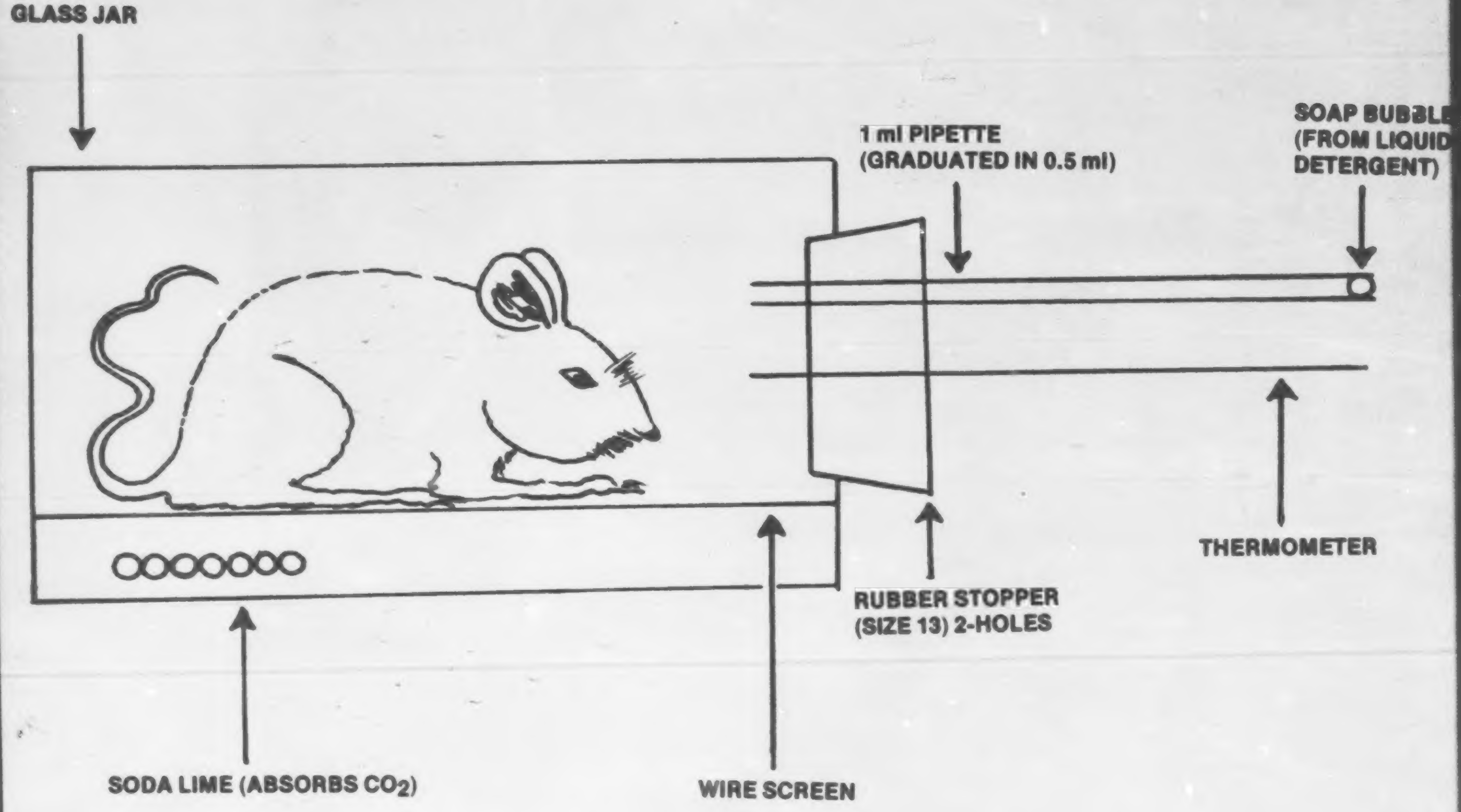
Activity:
(Continued)

during a school day. Remove feces before massing so as to determine the urine output on the basis of a 24 hour period. (Example: Urine Mass x 4 = Urine Mass/24 hour period.)

k. This experiment is to determine the oxygen consumption of a mouse. Consult the following two sources for information:
   - Your instructor.
   - Space Resources for Teacher - Biology, pages 50-54

l. See the drawing on the next page.

CONVERSION



MOUSE STUDY - METABOLISM

ANIMAL ENERGETICS DATA SHEET
(Sample)

Starting Date	Time	Mouse Weight	Food Pellet Weight Start	Food Pellet Weight End	Feces Weight	Food Scraps Weight

Calculations:

Ingestion = Food start - Food end - Food Scraps

Ingestion =

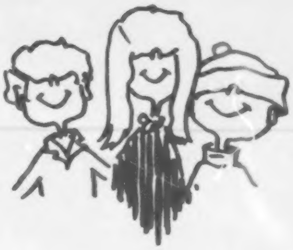
Ingestion = ________________ grams

Ingestion = Output + Stored Growth

Ingestion = Heat + Feces + Stored Growth

Heat + ______________ + ______________

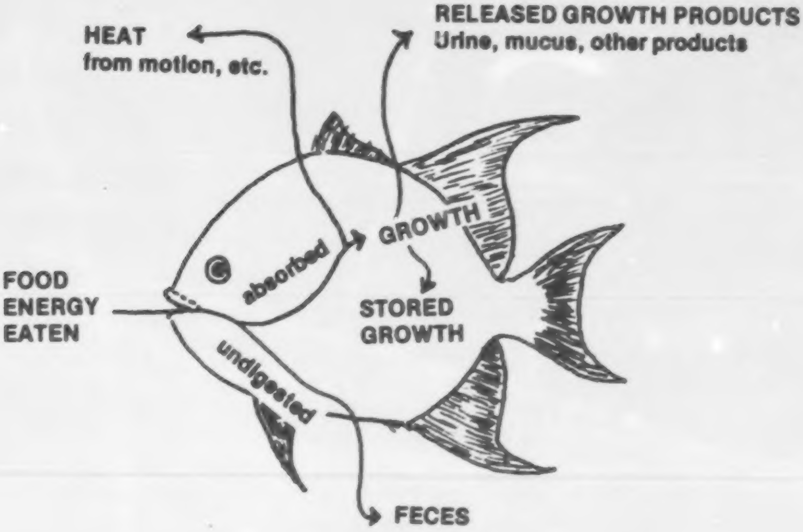
Heat = ____________________ grams of food energy



	Ingestion	Feces	Growth	Calculated Heat
Day 1				
Day 2				
Daily Average				

Activity: (Continued)

3. Discussion: Animals have four major energy flow routes. The energy an animal takes in leaves as heat, feces and released growth products, and some may be stored in the animal's new growth. These energy routes are shown in the diagram below:



INPUT = OUTPUT + STORED GROWTH

The equation INPUT = OUTPUT + STORED GROWTH describes the energy budget of any organism - plant or animal. In the diagram above, the output is equal to heat + feces + released growth products. As you know, all organic matter contains stored energy in its chemical bonds. Feces are made up of the food which the fish cannot digest. This food passes through the stomach and intestine, chemically unchanged. When it leaves the fish as wastes, it is still organic matter full of stored energy.

Activity: (Continued)

The released growth products are also organic matter; and, thus, they too contain energy. For example, the fish will produce mucus and eggs, if female. The chemical bond energy in these products must have come from food energy eaten by the fish. Can you think of some growth products which you release?

In general, the released growth products are small and can be ignored, as in the case of your mouse. However, when a fish releases many eggs, there can be a lot of energy released.

The energy which is in the organic matter of stored growth can be found in stored fats, or in the new bone, tissue and muscle of growing animals.

The energy budget of a plant can also be studied. The energy of sunlight is the input of energy to a plant. Most plants have little energy lost as organic wastes so the only output is heat. The other major energy route is that of stored growth. What per cent of the sun's energy do you think is absorbed and put into plant growth?

Whether there are two major energy routes or four, the important point is that all the food energy going into an organism can be accounted for. (Input = Output + Stored Growth.) There is no energy which simply disappears or is destroyed. Similarly, all the energy leaving an organism has a definite energy source. Energy can only come from other forms of energy; it can never be made.

The fact that energy can only come from other forms of energy is so important that it is known as The First Law of Thermodynamics.

Activity: (Continued)

The First Law states that energy cannot be made or destroyed, it can only be changed from one form to another.

All animals (including man) obey this law. There are no exceptions. The energy going in as food can be found in the products of heat, feces, stored growth and released growth products. The food energy entering an animal is not destroyed; the energy leaving and stored is not created. Instead, one form of energy is transformed into several other forms.

All changes in energy must follow this First Law of Thermodynamics. For example, when a bullet is fired from a gun, the energy of gunpowder (chemical energy) is changed to the energies of heat and of motion (kinetic energy). No energy is lost. The sum of the heat and motion energies is equal to the amount of original chemical energy.

Sunlight is another form of energy. It is called radiant energy. In green plants, it is captured and converted to chemical energy and heat energy. The conversion to chemical energy occurs when the carbohydrates (food) are manufactured. Energy is stored in the bonds which hold the carbohydrates together. Has the original energy from the sunlight been destroyed? No! It has only been converted to other forms of energy. When the chemical bonds are broken during cellular respiration in the plant (or in an animal which eats the plant), the energy is changed to still other forms.

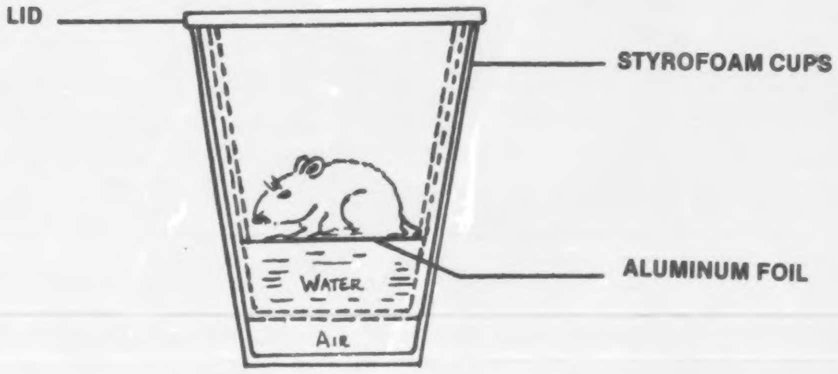
Activity: (Continued)

4. Heat Production. In the first experiment you measured every major energy flow route except heat. In this experiment you will measure heat production by the same mouse and will compare your measurement with the calculated heat found in the first experiment.

   a. Materials needed:
      1 mouse, small
      1 graduated cylinder, 25 ml
      1 thermometer calibrated to 0.1° C
      1 heat chamber with top
      1 watch
      1 scale weighing to 0.1 gram

   b. In this experiment you will seal your mouse in a closed, insulated chamber for a short period of time. Water will absorb the heat produced by the mouse. You can then measure the increased temperature of the water and thus calculate the heat produced. Not all the heat can be trapped and measured in this experiment. Can you figure out where heat is being lost or not measured?

   c. One cup has had the bottom cut out and a piece of aluminum foil covering the bottom and wrapped over the lip on the outside. Hopefully, the mouse will sit on the aluminum foil which will conduct heat to the water below.



Activity:
(Continued)

d. Carefully measure the volume of water which is trapped between the aluminum and the second cup holding the water. Record this volume on the Heat Production Data Sheet. Other cups can be used to increase the insulation so that more heat is held in the system.

5. To carry out this activity you should:
   a. Add about 40 ml of water (at room temperature) to the water cup so the cup is 1/3 to 1/2 full.
   b. Weigh the mouse and record the data.
   c. Measure the water temperature very carefully. Let the thermometer stay in the water for one minute before reading it. Record starting temperature.
   d. Over a sink insert the aluminum-bottom cup as deep as it can go, pushing out the excess water.
   e. Measure this trapped water volume and record the data after the experiment.
   f. Add your mouse to the heat chamber. Immediately cover the chamber and record the time the experiment started.
   g. Wait about 20 minutes - but no more than 25 minutes.
   h. Remove the mouse and aluminum bottom cup.
   i. Immediately take the temperature of the water while the water is still in the cup.
   j. Record the time when the mouse was removed and the maximum temperature measured in the water.
   k. Calculate the duration of the experiment and the temperature change.
   l. After a 20 minute period, repeat the process.

Activity: (Continued)

6. Discussion: Heat is measured in calories. In fact, all energy can be measured in calories; and, as you know, food contains calories. These calories are the food energy which can do work.

A calorie is defined as the amount of heat which will raise the temperature of 1.0 gram of water by 1.0 degree centigrade. If you add heat to change 12 ml (or 12 g) of water from 5^{0} C to 6^{0} C, then you have added 12 calories of heat.

To calculate the calories of heat produced by your mouse, multiply the volume of water times the temperature change. Record the number of calories released during the duration of your experiment.

If your mouse continues to produce calories at the same rate all day long, it will release a lot of calories. You can calculate the daily calorie production by using this formula:

$$\left(\frac{60 \text{ minutes}}{1 \text{ hour}}\right) \times \left(\frac{24 \text{ hours}}{1 \text{ day}}\right) \times \left(\frac{\text{Calories}}{\text{duration minutes}}\right) = \begin{array}{l}\text{Calories}\\ \text{Per Day}\end{array}$$

Solve this equation and record the number of calories produced in a day.

Optional: Assuming one gram of dry food contains about 4,500 calories, calculate the calories of heat produced. To do this, multiply the grams of food converted to heat times 4,500 and record the number on the Heat Production Data Sheet.

Compare the heat production values for the two methods. Can you explain the difference between these two values?

Activity: (Continued) 7. Report Instructions:

a. Your report should include graphs covered under activity #2, "e through h."

b. Determine the per cent of output (feces and urine) in comparison to the input (food and water).

c. Show calculations on a separate sheet.

d. Discussion of where the majority of the input (food and water) went. You might consider the following:

- Respiration.
- Energy in motion or stored.
- Energy conversions.
- Conservation of mass.

e. Include heat production experiment.

f. Answers to questions.

HEAT PRODUCTION DATA SHEET
(Sample)

RESEARCHER: ____________________

DATE: ____________________

TIME START: ____________________

TIME END: ____________________

DURATION: ____________________ MINUTES

MOUSE WEIGHT: ____________________ GRAMS

VOLUME OF WATER: ____________________ ML

TEMPERATURE START: ____________________ °C

TEMPERATURE END: ____________________ °C

TEMPERATURE CHANGE: ____________________ °C

CALORIES PRODUCED: ____________________ CALORIES

MEASURED CALORIES PER DAY: ____________________ CALORIES

CALCULATED CALORIES PER DAY: ____________________ CALORIES
(From Activity #1)

title: "Accommodation Of Waste Products"

conversion

concept: There are natural and artificial energy conversion systems subject to natural laws.

objective: Given the opportunity to complete a small group research activity, the student will be able to identify, in writing, support for the statement "The waste products from an artificial energy conversion system are more difficult for the natural environment to accommodate than waste from natural energy conversion systems."

time: Variable

subject matter area: Language Arts, Social Science

grade: 10-12

implementation:

Activity:

1. Divide the class into small groups, not less than four nor more than six to a group.

2. Allow each group to select one from the following list of topics:
   a. Nuclear Power
   b. Hydroelectric Power
   c. Petroleum Cracking Plants
   d. Coal Thermal Electric Plants

3. Each group is to define and describe (through research) the production and conversion processes involved in the selected topics. Written reports, charts, graphs, or other information may be used.

4. Each group will present their topic to the class in such a manner as to support the statement "The waste products from artificial energy conversion systems are more difficult for the natural environment to accommodate than waste from natural energy conversion systems."

materials:

activity no. 3

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implementation:

Activities: 5. Class discussion of each group's presentation
(continued) should follow the group presentations.

SUGGESTED CAREER EDUCATION ACTIVITY:

Given the opportunity to do the necessary research, the student will be able to identify occupations which are directly involved in the preservation of the natural environment.

materials:

SUGGESTED ASSESSMENT PROCEDURE:

Given the opportunity to listen to, and take part in, group presentations, the student will be able to identify, in writing, support for the statement "The waste products from a human-made energy conversion system are more difficult for the natural environment to accommodate than waste from natural energy conversion systems."

Developed by: Duane K. Altig
Parkrose School Dist.
Portland, OR

title: "Heat Conversion and Transfer"

conversion

concept: All conversion processes use energy or lose heat energy.

objective: Given the opportunity to complete an experiment, the student will be able to understand that heat can be converted and transferred from one place to another by molecular motion.

time: 1-2 45 minute class periods

subject matter area: Science

grade: 10-12

implementation:

Activity:

1. Assemble the apparatus so that you are heating about 1/2 a test tube of water and conducting the vapor (steam) to the second test tube, which should be immersed in a beaker of cold water.
2. With safety goggles in place, heat the test tube containing the water so that it boils rapidly, but not to the extent that liquid water is driven into the tubing. Boiling chips should be put in the water being heated to control boiling and prevent "bumping." REMEMBER: Do not point the test tube at anyone while heating it.
3. The delivery tube should be situated so that the water vapor is directed toward the bottom of the empty test tube in the beaker of cold water.
4. One of the thermometers should be placed in the beaker of cold water and an initial reading made.
5. The second beaker should be filled with cold water and placed near the first. The second thermometer should be placed in it and periodic readings of both thermometers taken.

materials:

1 alcohol burner or other heat source.
2 large test tubes.
1 one-hole stopper to fit test tube.
2 right-angle glass bends (might have to be made).
1 14" to 18" piece of tubing
2 600 ml beaker
2 thermometers
2 ring stands with clamps
Several boiling chips

safety glasses

WARNING: Students should be cautioned to follow correct laboratory procedures and to know safety rules.

activity no. 4

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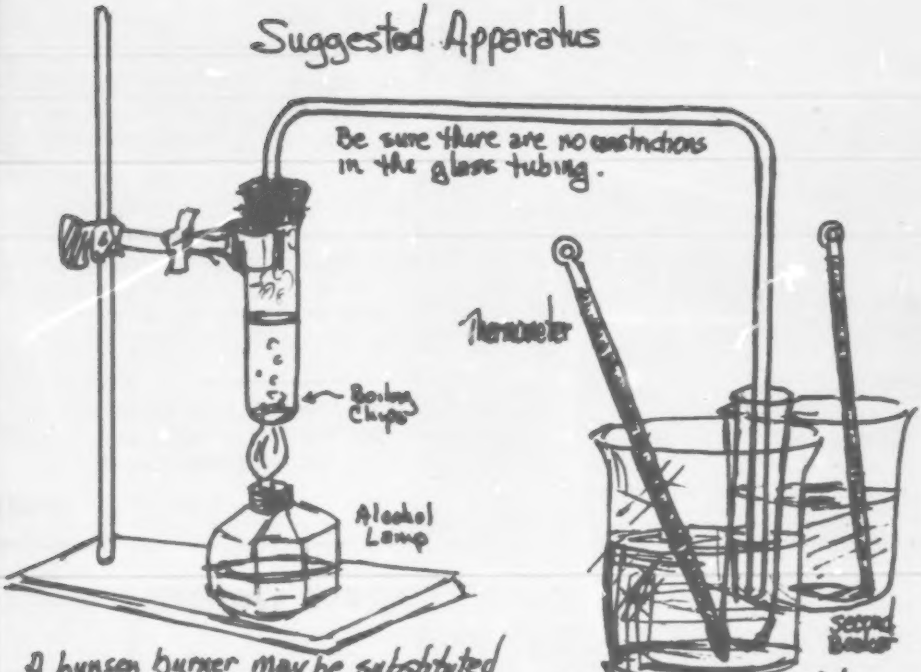
Suggested Apparatus



Be sure there are no constrictions in the glass tubing.

A bunsen burner may be substituted for the alcohol lamp.

implementation:

Activities: (cont.)

6. Heating should continue until about one half of the water in the test tube is boiled away (approximately 20 minutes).
7. Students should answer the evaluation questions and contribute to a discussion resulting from completion of the activity.

Questions:

1. In what form or state of matter did the water travel from the first to the second tube?
2. Could you see the water in this state? Why?
3. As the experiment progressed, what happened to the temperature of the water in the beakers?
4. What caused the change in temperature, if any?
5. Can you make a general statement about the state or form of heat energy possessed by that substance compared to a different form of the same substance?
6. Can energy be transferred from one place to another by changing the characteristics of a substance with heat?
7. Can you think of an example of this process in nature? Consider especially weather.

SUGGESTED CAREER EDUCATION ACTIVITY:

Given the opportunity to complete an experiment related to the conversion and transfer of heat by molecular motion, the student will be able to identify industrial and commercial activities as examples of the process and identify occupations related to the industrial and commercial activities identified.

materials:

SUGGESTED ASSESSMENT PROCEDURE:

Given an opportunity to complete an experiment related to the conversion and transfer of heat by molecular motion, the student will be able to complete a set of seven questions about the experiment and participate in a class discussion resulting from the completion of the activity.

Developed by: William Kintzley
Olympia, WA

Revised by: Duane K. Altig

title: "Efficiency and Energy Conversion"

conversion

concept: There are a variety of units of measure for the efficiency of energy conversion.

objective: Given the opportunity to understand efficiency equations, the student will be able to apply efficiency equations to specific heat producing energy conversions.

time: 1-2 45 minute class periods

subject matter area: Science, Mathematics

grade: 10-12

implementation:

Activity: 1. Introduction to efficiency.

a. (The task is to build up ideas about common use or measures of efficiency.) Ask students if they have heard about miles per gallon rating for various cars. What does mpg mean? Does mpg tell you anything about the car?

b. What is meant by efficiency? (Student may want to use dictionaries, etc. to help define.)

2. Use of efficiency for energy conversions.

a. How might we describe efficiency when we convert an energy source (coal, oil, nuclear fuel) to doing mechanical work?

Energy (Coal) → Energy (Thermal) → Work

b. Is all the fuel going to useful work or the thing we want done? What other factors do we need for our equation?

materials:

Film: "You Can't Go Back"
Elementary Penguin Productions
1043-3 South Westmoreland
Los Angeles, CA 90006

activity no. 5

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implementation:

Activities:
(continued)

The energy is accountable at each step. Not all of the energy goes to useful work. This reduces the efficiency.
The high temperature thermal energy is converted to mechanical energy or work and lower temperature thermal energy.

Energy________ Energy + Energy

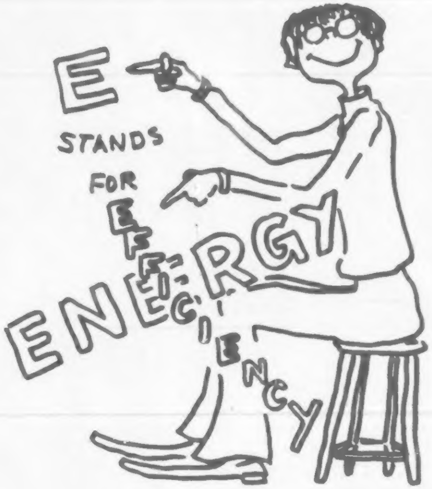
or

Energy (thermal) ________ Energy (mechanical) + Energy (thermal)

High Temperature Heat Reservoir ______ Mechanical Energy + Low Temperature Heat Reservoir

c. The chart tells us that heat (thermal) energy at the high temperature can be partly converted to mechanical energy, which does the work. The remainder of the heat energy is lost to the low temperature reservoir.
   - How would you determine the efficiency or the amount of mechanical energy converted from the high temperature reservoir? Remember, the amount of net work done by the mechanical energy is not ideal because of friction, internal heat losses and the multitude of places where mechanical energy is not used. Remember the number of ways the energy in an automobile is used. If the conversion were 100% from heat to mechanical energy what equation would you set up? $\frac{\text{mechanical energy}}{\text{heat energy}}$? close!

materials:



implementation:

Activities:
(continued)

But you need to multiply by 100 to change to a percent. Now, does your equation look like this?

$$\frac{ME}{HE} \times 100 = \%\text{ efficiency?}$$

- We could use the equation to measure efficiency, but as we previously stated mechanical energy is not always possible to measure. Going back to equation.

$$\underset{\text{(heat)}}{\text{Energy}} \longrightarrow \underset{\text{(mechanical)}}{\text{Energy}} + \underset{\text{(heat)}}{\text{Energy}}$$

solve the equations for mechanical energy. Now we have an equation that gives percent efficiency in terms of the high and low temperature heat reservoirs.

$$\frac{\text{high-low}}{\text{high}} \times 100 = \%\text{ efficiency}$$

d. If the heat loss is only to the low temperature reservoir and the engine is built to operate on an ideal thermodynamic cycle, the temperatures of the heat reservoirs would determine the efficiency. Write an equation that expresses efficiency in terms of the temperatures.

$$\frac{T_1 - T_2}{T_1} \times 100 = \%\text{ maximum efficiency}$$

e. T_1 is the higher temperature expressed in degrees Kelvin. To do the temperature conversion from Celsius to Kelvin add 273^0 to the Celsius value.

materials:

implementation:

Activities: (continued)

Example: 22° C to 295° K. The Kelvin temperature scale is also the absolute temperature scale. Let's try some efficiency problems.

Given: $T_1 = 100^\circ C$ $\qquad T_2 = 25^\circ$

$$E_{max} = \frac{T_1 - T_2}{T_1} \times 100$$

$$= \frac{373-298}{373} \times 100$$

$$= \frac{75}{373} \times 100$$

$$= 0.201 \times 100$$

$$E_{max} = 20\%$$

-Where did the 373 come from? Oh yes, converting 100° C to degrees absolute (Kelvin). We must add the 273.

Here are some more problems. Fill in the blanks

	T_2 °C	T_1 °C	Efficiency %
1.	16	199	
2.	15.8	260.4	
3.		793	64
4.	16		73.5

materials:

SUGGESTED ASSESSMENT PROCEDURE:

Given the opportunity to understand efficiency equations, the student will be able to calculate (a teacher-determined number) of efficiency problems.

(See over for calculations and answers.)

Developed by: Ted Parker
Beaverton School Dist.
Beaverton, OR

CALCULATIONS AND ANSWERS TO EFFICIENCY PROBLEMS

1. $$\frac{T_1 - T_2}{T_1} \times 10^2$$

$$\frac{(199+273) - (16+273)}{199 + 273} \times 10^2 = 38.8\%$$

2. $$\frac{(260.4 + 273) - (15.8 + 273)}{(260.4 + 273)} \times 10^2 = 45.9\%$$

3. $$T_1 - T_2 = \%$$

$$T_1 - T_2 = (\%)(T_1)$$

$$- T_2 = (\%)(T_1) - T_1$$

$$T_2 = T_1 - (\%)(T_1)$$

$$= (793 + 273) - (0.64)(793+273)$$

$$= 1066 - 682.2$$

$$T_2 = 383.8^\circ \text{ K}$$

$$T_2 = 110.8^\circ \text{ C}$$

4. $$T_1 = \frac{T_2}{1 - 0.64}$$

$$T_1 = \frac{(16 + 273)}{1 - 0.735}$$

$$T_1 = \frac{289}{0.265}$$

$$T_1 = 1091^\circ \text{ K}$$

$$T_1 = 818^\circ \text{ C}$$

title: "A New Law?"

conversion

concept: There are ethical, legal, aesthetic, social, political, economic, biological, and physical benefits and problems associated with energy conversion.

objective: Given the opportunity to identify current energy problems, the student will be able to participate in designing and testing the acceptability of a proposed law to deal with a current energy problem.

time: Variable

subject matter area: Social Science

grade: 10-12

implementation:

Activity:

1. Discuss with the class current problems related to energy conversion and the environment. (Complile a list on the chalk board of the problems identified by the class.)
2. Divide the class into small groups and have the groups rank order the problems.
3. Have each group explain the ordering, and then have the entire class rank order the list of problems.
4. Select the highest ranked problem, and discuss with the class how they would deal with solving the problem.
5. Divide the class into groups to research various parts of the problem, and how each of these parts would be handled in a written law.
6. Construct a draft of a new law. (Polish the wording, etc. through class discussions.)

materials:

activity no. 6

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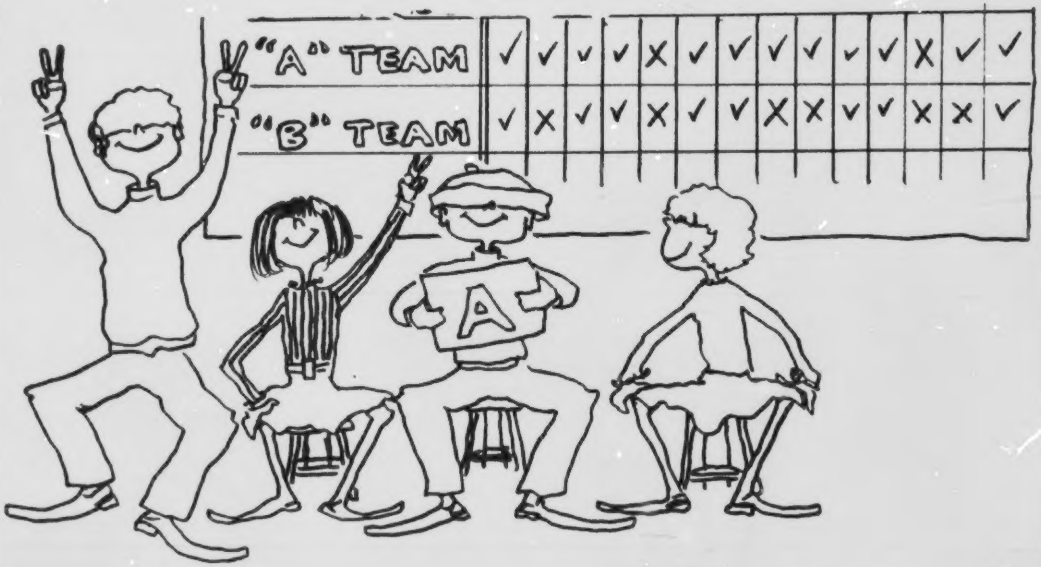
implementation:

Activities: (continued)

7. Test the acceptability of the law by conducting a survey of the school.

Optional Activities:

1. Test the acceptance of the law through a community survey.
2. Invite a local, federal, state, political representative to review the law and to discuss its merits and weak points with the class.



materials:

SUGGESTED ASSESSMENT PROCEDURE:

Given the opportunity to review current energy problems, the student will be able to participate in designing and testing the acceptability of a law to deal with a current energy problem.

Developed by: Duane K. Altig
Parkrose School Dist.
Portland, OR

title: "Benefits or Problems of Conversion Technology"

conversion

concept: There are ethical, legal, aesthetic, social, political, economic, biological, and physical benefits and problems associated with energy conversion.

objective: Given the opportunity to gather the necessary background information, the student will be able to identify ways that energy conversions may benefit a community.

time: 3-4 45 minute class periods

subject matter area: All

grade: 10-12

implementation:

Activity:

1. The instructor will describe a typical, primitive, tribal society. (i.e. American Indian, African Bushman, Australian Aborigine.)
2. Introduce the concept of the discovery of coal, etc.
3. Have students investigate, through discussion or actual research, the technology necessary for the conversion of coal, etc. to another form of energy.
4. The class will list all the possible changes that might result from an introduction of the level of technology required for the conversion of energy into the previously described primitive society.
5. The students, either in groups or individually, will identify the list of changes as benefits or costs to the life of the primitive society.

SUGGESTED CAREER EDUCATION ACTIVITY:

Given the opportunity to evaluate the differences between a modern and primitive society, the student will be able to identify how increased education and training have improved educational opportunities.

materials:

SUGGESTED ASSESSMENT PROCEDURE:

Given the opportunity to evaluate the introduction of technology to a primitive society, the student will be able to identify the benefits and problems of the technology of conversion to a primitive society.

Developed by:
Duane K. Altig
Parkrose School Dist.
Portland, OR

activity no. 7

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title: "Technology and Transportation"

conversion

concept: History can be described in terms of the level of energy conversion technology.

objective: Given the opportunity to evaluate the changes in transportation modes, the student will be able to describe the implications of technological changes on transportation.

time: 4-5 45 minute class periods

subject matter area: Social Science

grade: 10-12

implementation:

Activity:

1. Collect 10-12 pictures of various forms of transportation during the period of westward movement.
2. Post the pictures on a wall in the classroom - in any random manner.
3. Have each student arrange the pictures in some order - and explain the basis for their particular arrangement.
4. Divide the class into small groups, 4-5 students in each group.
5. The group is to arrange the pictures in some order that the group can agree upon. The group will present their arrangements and their reasons to the class.
6. Discuss the possible arrangement of pictures - as many as possible.

materials:

Pictures of modes of transportation during period of westward movement.

activity no. 8

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implementation:

Activities: (continued)

7. Now have each individual student organize the pictures into an order from least to most use of energy in providing transportation.

8. Discuss the implications of the changes in technology required to move from one form of transportation to another.

SUGGESTED CAREER EDUCATION ACTIVITY:

Given the opportunity to identify the changes which have occurred in transportation, the student will be able to assess the possibilities for occupational opportunities in the transportation field in future years.

materials:

SUGGESTED ASSESSMENT PROCEDURE:

Given the opportunity to identify the progression of development of energy use in transportation, the student will be able to discuss the changes in technology required in moving from one form of transportation to another.

Developed by: Duane K. Altig
Parkrose School Dist.
Portland, OR

IMPACTS OF ENERGY

GOAL:

IT IS ESSENTIAL THAT EACH PERSON KNOW HOW PEOPLE'S USE OF ENERGY CREATES AN IMPACT CN ENVIRONMENTAL AND ECONOMIC SYSTEMS.

ACTIVITY
DESCRIPTION PAGE

IMPACTS (10-12)

Goal: It is essential that each person know how people's use of energy creates an impact on environmental and economic systems.

Concept: Energy extraction and use alters original environmental conditions.

Activity #1 "Predicting Environmental Impact"
Grade level 11-12
All Subject Matter Areas

Given the opportunity to prepare an environmental evaluation matrix, the student will be able to learn that the environmental impact of a geothermal site may be predicted by preparing an environmental evaluation matrix.

Activity #2 "What Type Of Shopping Area?"
Grade level 10-12
All Subject Matter Areas

Given the opportunity to make comparisons of community areas, the student will be able to compare the relative aesthetic results with the relative energy requirements of several types of community organizations.

Concept: The use or non-use of any energy source requires environmental trade-offs.

Activity #3 "At Home With A Power Plant"
Grade level 10-12
Language Arts, Social Science

Given the opportunity to evaluate the location of a power plant, the student will be able to give a rationale for the selection of a power plant that will be built next to the student's home.

Concept: Various energy sources have differing impacts on the environment.

Activity #4 "Environmental Impacts Of Transportation"
Grade level 10-12
All Subject Matter Areas

Given the opportunity to complete a number of activities, the student will be able to trace the development of transportation in the U.S. from its earliest forms to the present day and list environmental impacts of modern transportation.

ACTIVITY
DESCRIPTION PAGE

IMPACTS (10-12) (continued)

Concept: Conflicts over ecologically sound practices and aesthetic judgments will involve trade-offs if they are to be resolved.

Activity #5 "Lifestyle Choices And Energy Use"
Grade level 9-10
All Subject Matter Areas

Given the opportunity to assess a list of personal energy use choices, the student will be able to form judgments using terms good, bad, right, wrong, better, worse, etc. with regard to lifestyle choices that deal with energy use.

Activity #6 "Unwise Energy Use"
Grade level 9-10
Language Arts, Speech, Social Science

Given the opportunity to observe the interactions of people regarding energy use choices, the student will be able to confront (hypothetically and in reality) any source of "unwise" energy use.

Activity #7 "Future Nuclear Plant Sites"
Grade level 8-10
All Subject Matter Areas

Given the opportunity to role play, the student will be able to describe reactions to future siting possibilities for nuclear power plants.

Activity #8 "Freedom Of Choice vs. Energy Conservation Programs"
Grade level 10-12
Social Science, Language Arts

Given the opportunity to evaluate a number of activities, the student will be able to list those areas of personal freedom of choice that would be more closely controlled or taken away in energy conservation programs.

Activity #9 "Site Review"
Grade level 10-12
All Subject Matter Areas

Given the opportunity to complete a number of activities, the student will be able to demonstrate an understanding of the factors involved in siting a plant by presenting a hypothetical site review for a given model, backed by evidence and based on the six factors of siting as they apply to the given situation.

ACTIVITY
DESCRIPTION PAGE

IMPACTS (10-12) (continued)

Activity #10 "The Alaska Pipeline: An Energy Dilemma"
Grade level 10-12
All Subject Matter Areas

Given the opportunity to read conflicting articles, the student will be able to recognize the issues involved in meeting our energy needs and protecting the environment.

Concept: Efforts to regulate energy producers and users require energy, economic allocation, and political effort.

Activity #11 "Traditional Values And Energy-Use Problem Solving"
Grade level 8-10
Language Arts, Social Science

Given the opportunity to collect the necessary materials, the student will be able to use information from local decision-making groups (planning boards, city council) to apply traditional values listed to the decision-making process and describe their impact upon energy-use problem solving.

Activity #12 "Special Interest Groups"
Grade level 10-11
Social Science, Language Arts

Given the opportunity to research the particular concerns of selected special interest groups, the student will be able to identify their impact on the regulation of energy producers and users.

Concept: Some uses of energy are more threatening to ecosystems than are others.

Activity #13 "Pros And Cons Of Energy Use"
Grade level 10-12
Language Arts, Social Science

Given the opportunity to read differing opinions on the use of coal, the student will be able to recognize the trade-offs involved in any attempt at a solution to the problems of energy use.

Activity #14	"Creative Descriptions Of Natural Pollutants Or Contaminants" Grade level 10-12 All Subject Matter Areas Given the opportunity to complete the necessary research, the student will be able to describe (written, pictorial, poem, music, etc.) the processes involved in the production of a natural pollutant or contaminant.
Concept:	The environmental and economic consequences of energy use require additional energy.
Activity #15	"A Week Of Garbage" Grade level 10-12 Social Science, Mathematics, Science Given the opportunity to evaluate the recycling potentials of garbage, the student will be able to demonstrate a knowledge of the volume of solid waste produced and the percentage of its components.
Concept:	New technologies and careers have resulted from the environmental impact of energy.
Activity #16	"Careers In Environmental Science" Grade level 10-12 All Subject Matter Areas Given the opportunity to explore, the student will be able to identify career opportunities in the field of environmental science.

title: "Predicting Environmental Impact"

impacts

concept: Energy extraction and use alters original environmental conditions.

objective: Given the opportunity to prepare an Environmental Evaluation Matrix, the student will be able to learn that the environmental impact of a geothermal site may be predicted by preparing an Environmental Evaluation Matrix.

time: 3-4 45 minute class periods

subject matter area: All

grade: 11-12

implementation:

Activity:

1. Introduce the subject of environmental impact of geothermal plants by showing 35mm colored slides of possible future sites in your own state and the present geothermal site at the Geysers in California. Show the slides through the first time without comment.

2. Propose to the students that they have been hired by a utility company to prepare the matrix used to file the Environmental Impact Statement.

3. Show the slides again, but this time have the students write a list of possible changes to the land, air and water at potential geothermal sites. Do not evaluate the possible changes to the environment at this time.

4. Give the students the Enviromental Evaluation Matrix form. Explain that the purpose of the matrix is to provide the data that will be used in identifying changes in the environment that are caused by the project under consideration. This form is prepared by the U. S. Geological Survey.

5. Give the students the directions for the matrix form.

materials:

Slide projector
Try to obtain slides of potential geothermal sites in your state. Contact EME for information on obtaining slides of the Geysers in California.

Films

"Geothermal Power: The Great Furnace"
Educational Media Center
University of Colorado
Boulder, CO 80309

"Geothermal: Nature's Boiler"
Department of Energy
Film Library
P.O. Box 62
Oak Ridge, TN 37830

activity no. 1

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implementation:

Activity: (continued)

6. Divide the students into teams of two or three to provide the opportunity for idea exchange on the factors considered. The slides should be available for student use while they are completing the matrix.
7. Have the students list possible field studies that would provide data for an objective study rather than the subjective approach used in class.
8. Research on problems arising with geothermal development in Mexico would add perspective.

Optional Activities:

1. Of the proposed actions listed in the Environmental Evaluation Matrix, list three that you feel would have the greatest beneficial effect on the environment.
2. Describe the field studies that you would need to do to determine objectively the criteria for your choices in #1.
3. Examine the matrix form that you've completed. Determine which part of the environment--land, air, or water would be most adversely affected by a geothermal plant. Discuss the reasons for your choice.

SUGGESTED CAREER EDUCATION ACTIVITY:

Given the opportunity to view a film on the use of new energy sources, the student will be able to identify at least 20 new occupations shown in the film.

materials:

SUGGESTED ASSESSMENT PROCEDURE:

Given the opportunity to complete an Environmental Evaluation Matrix, the student will be able to identify how the environmental impact of a geothermal site may be predicted.

Developed by: Marlene Lindstrand
Everett School District
Everett, WA

Matrix Form for the Environmental Impact Statement

Purpose of the study: To learn how to use the matrix form.
To identify the kind of data needed to compile the matrix form.
To identify possible environmental effects of a geothermal plant.

Plan:

1. Introduction: Series of slides showing a geothermal plant and the proposed geothermal sites.

2. From the slides identify some of the specific effects that a geothermal plant would have on the land, the quality of water, the quality of the air and the vegetation.

3. Refer to the Proposed Actions Which May Cause Environmental Effect list. From the Proposed Action list select three actions that would apply to the effects that a geothermal plant would have on the land, water, air and vegetation.

   Example: Land. From the Proposed Action list these items were selected: Modification of habitat
   Erosion control and terracing
   Scarification

4. Write the proposed actions you have selected at the top of the matrix work sheets: Physical and Biological sheet, Cultural sheet.

5. Select three appropriate characteristics from the work sheet matrix for each of the Proposed Actions you have listed by making a diagonal line through the squares which apply.

   Example:

	Modification of habitat	
soils	/	
surface water	/	
stability (slides, slumps)	/	

6. Determine if the proposed action (modification of habitat) would be beneficial or detrimental to the characteristics (soil, surface water, stability) selected. Mark a + if it is beneficial or a - if it is detrimental.

   Example:

soils	−/	

7. Rate the effect of the proposed action on a 1 - 3 scale: 1 = minimal effect, 2 = moderate effect, 3 = maximum effect. Your rating will be subjective.

Example:

soils	—/3	

8. When preparing this matrix form for an actual study, field data are used to rate the effect on the 1 to 3 scale. For each of the characteristics you have selected, (soils, surface water, stability) describe one field study that could be used to objectively rate the effect of the proposed action on the environmental characteristics.

Example:

Characteristics	Rate	Field Study
Soil	—/3	Soil horizon survey
Surface Water		Water holding capacity of soil

ENVIRONMENTAL EVALUATION MATRIX

1. Listed below are some of the actions which may be involved during the course of a project. Actions which are not listed but are a part of the project should also be considered. Select the action or actions which apply and write them in under proposed actions on pages 2 and 3.

2. On pages 2 and 3 under each proposed action that has been identified, the rater will place a diagonal slash in each square opposite each existing characteristic or condition that will be affected by that action.

3. Above every slash the rater will place either a + if the effect is beneficial or a - if the effect is detrimental. Below the slash, the rater will place either 1, 2 or 3 for magnitude of impact; 1 for a minor effect, 2 for moderate, and 3 for major.

4. Assignment of numerical weights to magnitude should be based on factual data rather than preference. It should be as nearly as possible free from personal bias.

PROPOSED ACTIONS WHICH MAY CAUSE ENVIRONMENTAL EFFECT

MODIFICATION OF REGIME

a. Biological controls
b. Modification of habitat
c. Alteration of ground cover
d. Alteration of ground water hydrology
e. Alteration of drainage
f. River control and flow modification
g. Canalization
h. Irrigation
i. Weather modification
j. Burning
k. Surface or paving
l. Noise and vibration

LAND TRANSFORMATION AND CONSTRUCTION

a. Trail construction
b. Industrial sites and buildings
c. Airports
d. Highways and bridges
e. Road construction
f. Cables and lifts
g. Transmission lines, pipelines and corridors
h. Barriers including fencing
i. Channel dredging and straightening
j. Channel revetments
k. Canals
l. Dams and impoundments
m. Piers, seawalls, marinas and sea terminals
n. Recreational structures
o. Blasting and drilling
p. Cut and fill
q. Tunnels and underground structures

CHANGES IN TRAFFIC

a. Railway
b. Automobile
c. Trucking
d. Shipping
e. River and canal traffic
f. Pleasure boating
g. Trails
h. Cables and lifts
i. Communication
j. Pipeline

CHEMICAL TREATMENT

a. Fertilization
b. Chemical deicing of highways, etc.
c. Chemical stabilization of soil
d. Weed control
e. Insect control (pesticides)

RESOURCE EXTRACTION

a. Blasting and drilling
b. Surface excavation
c. Subsurface excavation and restoring
d. Well drilling and fluid removal
e. Dredging
f. Clear cutting and other lumbering
g. Commercial fishing and hunting

PROCESSING

a. Farming
b. Ranching and grazing
c. Feed lots
d. Dairying
e. Energy generation
f. Mineral processing
g. Food
h. Lumbering
i. Pulp and paper

LAND ALTERATION

a. Erosion control and terracing
b. Mine sealing and waste control
c. Strip mining rehabilitation
d. Landscaping
e. Harbor dredging
f. Marsh fill and drainage
g. Scarification

RESOURCE RENEWAL

a. Reforestation
b. Wildlife stocking and management
c. Ground water recharge
d. Fertilization application
e. Waste recycling

WASTE REPLACEMENT AND TREATMENT

a. Ocean dumping
b. Landfill
c. Emplacement of tailings, spoil and overburden
d. Underground storage
e. Oil well emplacement
f. Deep well emplacement
g. Cooling water discharge
h. Municipal waste discharge including spray irrigation
i. Liquid effluent discharge
j. Stabilization and oxidation ponds
k. Septic tanks, commercial and domestic
l. Stack and exhaust emission
m. Spent lubricants

ACCIDENTS

a. Explosions
b. Spills and leaks
c. Operational failure

ENVIRONMENTAL EVALUATION MATRIX

Application No. ______________________

Project Title ______________________

Area ______________________

District ______________________

Subdivision ______________________

Sec.________ T.__________ R.__________ W.M.

EXISTING CHARACTERISTICS AND CONDITIONS OF THE ENVIRONMENT

			Proposed Actions
PHYSICAL AND CHEMICAL CHARACTERISTICS	1. EARTH	a. Mineral resources	
		b. Bed Rock Geology	
		c. Soils	
		d. Land form	
		e. Surficial Geology	
		f. Unique physical features	
		g.	
	2. WATER	a. Surface	
		b. Ocean	
		c. Underground	
		d. Quality	
		e. Temperature	
		f. Recharge	
		g. Snow; ice and permafrost	
		h.	
	3. ATMOSPHERE	a. Quality (gases, particulates)	
		b. Climate (micro, macro)	
		c. Temperature	
		d.	
	4. PROCESSES	a. Floods	
		b. Erosion	
		c. Deposition (sedimentation, precipitation)	
		d. Solution	
		e. Sorption (ion exchange, complexing)	
		f. Compaction and settling	
		g. Stability (slides, slumps)	
		h. Stress-strain (earthquake)	
		i. Air movements	
		j.	
BIOLOGICAL CONDITIONS	1. FLORA	a. Trees	
		b. Shrubs	
		c. Grass	
		d. Crops	
		e. Microflora	
		f. Aquatic plants	
		g. Endangered species	
		h.	
	2. FAUNA	a. Birds	
		b. Land animals including reptiles	
		c. Fish and shell fish	
		d. Benthic organisms	
		e. Insects	
		f. Microfauna	
		g. Endangered species	
		h. Barriers	
		i. Corridors	
		j.	
	OTHERS	a.	
		b.	

title: "What Type Of Shopping Area?"

impacts

concept: Energy extraction and use alters original environmental conditions.

objective: Given the opportunity to make comparisons of community areas, the student will be able to compare the relative aesthetic results with the relative energy requirements of several types of community organizations.

time: Variable

subject matter area: All

grade: 10-12

implementation:

Activity:

1. A comparison by the class should be made between a centralized shopping center or shopping mall with row businesses as are found in most towns and cities. In order to make a reasonable comparison, the same number (20? 30? more?) establishments should be surveyed in each area. Futhermore, it is not fair, for instance, to compare a little convenience grocery with a chain-owned supermarket.

2. Establish how many cars reach a set number of stores and business establishments per day in each place. Do people drive more miles in a month's time to shop in a mall or centralized shopping area than they do going between widely dispersed shops? Automobile counts may be available through marketing specialists or the local Chamber of Commerce.

3. Ascertain which shopping arrangement contributes more to community quality or degradation?

4. Gather information about which shopping arrangement contributes more to the community's tax structure? Tax information should be sought through the Chamber of Commerce or municipal government agencies.

materials:

Local map
Paper
Pencil
Film
Photographs of areas being studied.

equipment:

Camera
Slide projector

activity no. 2

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Activity No. 2 (page 2)

implementation:

SUGGESTED CAREER EDUCATION ACTIVITY:

Given an opportunity to survey a local shopping center, the student will be able to identify a variety of different occupations which deal directly with the shopping center.

materials:

SUGGESTED ASSESSMENT PROCEDURE:

Given an opportunity to view a slide show of an area under consideration, and listen to oral reports from the several teams about their findings, the student will be able to write a paper defending, with logical arguments, the type of shopping area he feels most benefits his community.

Developed by: Lois Helton
Beaverton School District
Beaverton, OR

title: "At Home With A Power Plant"

impacts

concept: The use or non-use of any energy source requires environmental trade-offs.

objective: Given the opportunity to evaluate the location of a power plant, the student will be able to give a rationale for the selection of a power plant that will be built next to the students home.

time: Variable

subject matter area: Language Arts, Social Science

grade: 10 - 12

implementation:

Activity:

1. You have learned that the power company is going to place an electrical generating plant next to your home. You cannot move. Select the type of electrical power plant you would prefer to have built and support your reasons.
2. Some factors to consider:
   - a. Construction problems
   - b. Noise
   - c. Traffic - rail or road
   - d. Looks
   - e. Waste removal
   - f. Other

CONSIDER THESE FACTORS

SUGGESTED CAREER EDUCATION ACTIVITY:

Given the opportunity to evaluate the type of power plant to be constructed near their home, the students will be able to list the occupations that would be involved in the plant construction.

materials:

SUGGESTED ASSESSMENT PROCEDURE:

Given the problem of the location of a power plant, the student will be able to select the type of power plant that s/he prefers and support in writing the reasons for the selection.

Developed by: Ted Parker
Beaverton School Dist.
Beaverton, OR

activity no. 3

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title: "Environmental Impacts Of Transportation"

impacts

concept: Various energy sources have differing impacts on the environment.

objective: Given the opportunity to complete a number of activities, the student will be able to trace the development of transportation in the U. S. from its earliest forms to present day and list environmental impacts of modern transportation.

time: Variable

subject matter area: All

grade: 10-12

activity no. 4

implementation:

Activity:

1. Show film on transportation and its implications.
2. Divide class into small groups. Research the development of transportation from early Indians through the present in the U. S.
3. As a class make a time-line of important development in U. S. transportation. (Display)
4. Have students interview parents and grandparents concerning changes in transportation they recall. Consider changes in methods as well as trends.
5. Have students discuss and list the impacts that modern forms of transportation have had on the environment. Consider noise and air pollution, space for roads, freeways, energy consumption, etc.
6. Each student will prepare 7cm x 10cm cardboards heavily coated with vaseline. Go to the school parking lot. Choose large, small, old and new models of cars. Include one with a pollution device, if possible. WARNING: Do not breathe

materials:

Films

"Power And Wheels: The Automobile in Modern Life"
Encyclopedia Brittanica
Educational Corporation
425 North Michigan Avenue
Chicago, IL 60611

"Autos And All That Traffic"
McGraw Hill Films
1221 Avenue of the Americas
New York, NY 10020

16 mm projector

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implementation:

exhaust or touch exhaust pipes, which are extremely hot. Teacher should supervise.

Having obtained the permission of the car owner, start the car's engine and collect exhaust emissions on the cardboard by holding the cards directly behind the exhaust pipe. Record the year and make of the car on the card. Be sure to run each engine for the same length of time. Compare and discuss findings. Record class findings on a chart. Please note:

a. Scientific supply houses may be contacted to obtain kits for emission testing.
b. Information on emission standards may be obtained from the local or state environmental quality commission.

Divide the class into groups. At a different time each day, each group will inventory traffic at a location near the school and record its findings on a classroom chart.

Date	Time	No. of Vehicles	Vehicles Emitting Black Exhaust	Noisy Vehicles	No. of Passengers

After all groups have reported, the class can tally the last three columns and figure the precentage of vehicles which are polluting air or noise level.

materials:

implementation:

Activity:
(continued)

9. The student will examine his own use of the auto and develop a plan for reduction of use.

10. The student will describe changes in his family's daily activities which would result if they had no auto.

11. The student will keep a journal of all his family's uses of transportation for one week.

12. The student will examine his record for the following considerations. When would it have been as practical, considering environmental impacts as well as convenience, to:
    - a. Walk.
    - b. Ride a bike.
    - c. Carpool.
    - d. Use mass transit.
    - e. Other.

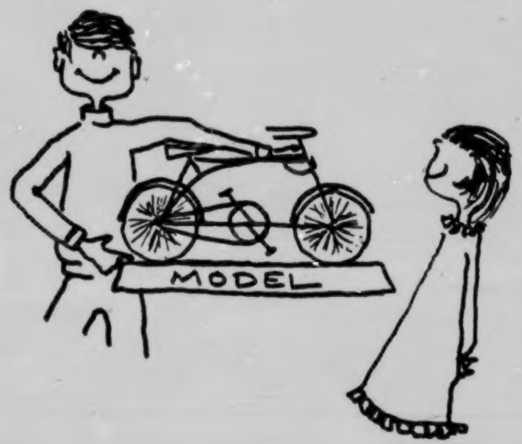
13. The student will formulate a plan of action from his examination. He will implement this plan for no less than one week.

14. As a class, discuss changes made in transportation use and lifestyle effects. Discuss personal advantages and disadvantages.

Optional Activities: (individual or small groups)

15. The student will pretend he is to write a law restricting the use of personal autos to reduce air, noise and space pollution and gas consumption.

materials:



2

implementation:

Activity: 16. (continued) The student will find out what people in his community think should be done to control auto pollution. Make findings known to legislators. Invite a city councilman to visit the class so that the issue can be discussed with him.

SUGGESTED CAREER EDUCATION ACTIVITY:

Given the opportunity to discuss the occupational opportunities in transportation with a union official, the student will be able to identify the economic and non-economic advantages and disadvantages of union membership.

materials:

SUGGESTED ASSESSMENT PROCEDURE:

Given the opportunity to complete a number of activities related to transportation, the student will be able to trace the development of transportation and identify the environmental impacts of modern transportation.

Developed by: Kathy Walker
Crest Drive School
Eugene, OR

title: "Lifestyle Choices And Energy Use"

impacts

concept: Conflicts over ecologically sound practices and aesthetic judgments will involve trade-offs if they are to be resolved.

objective: Given the opportunity to assess a list of personal energy-use choices, the student will be able to form judgments using terms good, bad, right, wrong, better, worse, etc., with regard to lifestyle choices that deal with energy use.

time: 3- 45 minute class periods

subject matter area: All

grade: 9-10

implementation:

Activity:
1. The student is to assess the ways in which s/he uses energy. It should be emphasized that personal choice is involved in energy use.
2. Student assigns priorities within the list in terms of necessity.
3. Student then attempts to calculate roughly the gross amount of energy he uses over a set period of time (day, week, etc.).
4. Student attempts to judge his own wise and unwise uses of energy (forming judgments about choices taken).
5. Class discussion of these items.
6. Class passes judgment on a collection of these uses. (This is intended to focus attention on our energy-intensive lifestyles.)

materials:

Films

"The Energy Dilemma"
Films, Inc.
5625 Hollywood Blvd.
Hollywood, CA 90028

"Leisure"
Pyramid Films
P.O. Box 1048
Santa Monica, CA 90406

activity no. 5

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implementation:

7. Student expands awareness to the community and larger spheres. Lists energy-using activities and attempts to pass judgment on them justifying their conclusions.
8. Some kind of tally of "goods" and "bads" to be brought to class attention.

SUGGESTED CAREER EDUCATION ACTIVITY:

Given the opportunity to evaluate the energy uses of given lifestyles, the student will be able to identify through class discussions occupations which produce greater uses of energy.

materials:

SUGGESTED ASSESSMENT PROCEDURES:

Given the opportunity to evaluate the advantages and disadvantages of energy intensive lifestyles, the student will be able, through class discussion, to generate a list of good and bad uses of energy-using activities.

Developed by: G. Lass
Beaverton School Dist.
Beaverton, OR

title: "'Unwise' Energy Use"

impacts

concept: Conflicts over ecologically sound practices and aesthetic judgments will involve trade-offs if they are to be resolved.

objective: Given the opportunity to observe the interactions of people regarding energy use choices, the student will be able to confront (hypothetically and in reality) any source of "unwise" energy use.

time: 4-5 45 minute class periods

subject matter area: Language Arts, Speech, Social Science

grade: 9-10

implementation:

Activity:

1. After observing a mock confrontation over energy use between two parties, students will try to evaluate why and how people are resistant to behavioral change. Also, each student will list possible steps that s/he would take in trying to change a person's behavior.

2. Analyze and evaluate in class the steps listed by students.

3. Have students divide into two main groups, protagonist and antagonist. Have the members of the protagonist group prepare short justifications for their unwise way of consuming energy. Have the antagonists each devise approaches to persuade or influence the others.

4. Randomly select any two or three students, protagonist and antagonist, and have them perform a short confrontation scene. Class evaluates approaches to persuasion.

5. Students are encouraged to confront people littering or being wasteful of resources, etc. and report the reaction of the offender to the attempts to influence him/her.

materials:

activity no. 6

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implementation:

SUGGESTED CAREER EDUCATION ACTIVITY:

Given the opportunity to identify unwise uses of resources, the student will be able to identify occupations which are directly related to unwise energy use.

materials:

SUGGESTED ASSESSMENT PROCEDURE:

Given the opportunity to observe interactions of people regarding energy use choices, the student will be able to report the reactions of people to confrontations relative to unwise uses of resources.

Developed by: G. Lass
Beaverton School Dist.
Beaverton, OR

title: "Future Nuclear Plant Sites"

impacts

concept: Conflicts over ecologically sound practices and aesthetic judgments will involve trade-offs if they are to be resolved.

objective: Given the opportunity to role play, the student will be able to describe reactions to future siting possibilities for nuclear power plants.

time: 3-4 45 minute class periods

subject matter area: All

grade: 8-10

activity no. 7

implementation:

Activity:

1. Choose locations for three new generating plants in your state. Establish their exact sites.
2. Discuss the characteristics of the fuel to be used in the plants.
3. Discuss the transportation problems related to fuel and waste. See Activity #1 in this section for other impacts.
4. What might the reactions to each site be from: a banker, a housewife, a person picked at random, an industrialist, a conservation club president, a hospital manager, a realtor, and a supermarket owner?
    - a. Have students role-play possible responses from these various concerned citizens.
    - b. Ask students to discuss their own reactions to each site.

SUGGESTED CAREER EDUCATION ACTIVITY:

Given the situation of the possibility of a nuclear power plant, the student will be able, through class discussion, to identify reasons why some occupations and/or lifestyles may differ on their judgments relative to the trade-offs involved in nuclear power plant development.

materials:

SUGGESTED ASSESSMENT PROCEDURES

Given the necessary background information, the student will be able to role play the reactions of a variety of individuals to the siting of future nuclear power plants.

Developed by: Dick Mace
Beaverton School District
Beaverton, OR

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title: "Freedom Of Choice vs. Energy

impacts

concept: Conflicts over ecologically sound practices and aesthetic judgments will involve trade-offs if they are to be resolved.

objective: Given the opportunity to evaluate a number of activities, the student will be able to list those areas of personal freedom of choice that would be more closely controlled or taken away in energy conservation programs.

time: 2-3 45 minute class periods

subject matter area: Social Science, Language Arts

grade: 10-12

implementation:

Activity:

1. Mobility: The student evaluates his family's level of mobility (ski trips, three cars, etc.) and predicts what it will be like if stronger federal controls on auto pollution and trends toward mass transit come into effect.

2. Free Enterprise System: The student evaluates the impact of a market economy on the use of energy resources and considers how that system will be affected by tougher energy conservation programs (include real estate use, suburban sprawl, less plastic packaging). Student could go to supermarket and list plastic packaging, excess packaging, etc.

3.

   control upon the prices of manufactured goods.

4. The student will attempt to describe the lifestyle that will follow from one of the below:
   a. Tougher, more closely regulated energy-use program.
   b. A total depletion of the many non-renewable energy sources.
   c. The necessary changes in sources of energy and their impact upon lifestyles.

materials:

activity no. 8

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implementation:

SUGGESTED CAREER EDUCATION ACTIVITY:

Given the opportunity to review a number of occupations in the area of conservation, the student will be able to identify those occupations which match the students aptitudes and interests.

materials:

SUGGESTED ASSESSMENT PROCEDURE:

Given the opportunity to evaluate the effects of tighter controls in energy conservation, the student will be able to list personal freedoms that would be controlled or eliminated.

Developed by: G. Lass
Beaverton School District
Beaverton, OR

title: "Site Review"

impacts

concept: Conflicts over ecologically sound practices and aesthetic judgments will involve trade-offs if they are to be resolved.

objective: Given the opportunity to complete a number of activities, the student will be able to demonstrate an understanding of the factors involved in siting a plant by presenting a hypothetical site review for a given model, backed by evidence and based on the six factors of siting as they apply to the given situation.

time: Variable
15-25 45 minute
class periods

subject matter area: All

grade: 10-12

implementation:

Activity:

1. The six categories involved in the siting process are:
   a. System planning.
   b. Safety.
   c. Engineering.
   d. Environmental factors.
   e. Institutional factors.
   f. Economic factors.

Each of these categories is explored by the student in the following learning activities:

2. System planning is the process of determining where ideal locations for plants would be, taking into consideration the total energy picture for a region. From such a study comes a list of possible sites that are then analyzed for advantages and disadvantages from two major viewpoints; i.e., societal outlook and enterprise outlook.

   a. What are the power requirements of an area? The students will construct a working model, using their immediate community for data.
      - Student conducts research to determine the energy needs of a hypothetical community. (Skills: inter-

materials:

Telephone books for locating necessary contacts with agencies and persons used as resources.
Mapping materials for making models.
Demographic tables and various statistics to use as source material for models. (Utility yearbooks, stockholders annual reports, etc.)

activity no. 9

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implementation:

Activities:
(continued)

viewing, categorizing, analyzing, hypothesizing, constructing maps, charts and graphs, interpreting maps, charts and graphs and valuing.)

Residential consumption is determined by polling a representative number of households for annual consumption estimates, averaging them, and multiplying that factor by projected number of residences.

Industrial consumption is determined by students gathering this evidence by surveying, interviewing, researching of industrial reports, trade journals and by reasonable projections.

Commercial consumption is estimated by surveys, interviews and reasonable projections.

Total energy needs are figured as a sum of the above consumption rates.

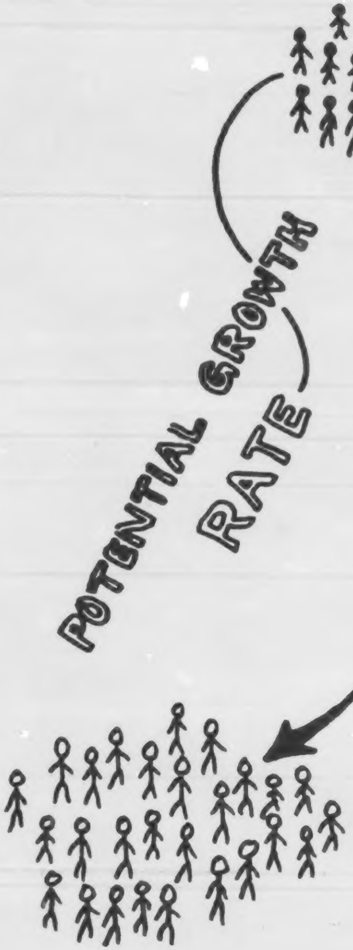
b. What are the existing sources to meet these requirements? The student constructs a model using actual community data to locate energy sources.
- The public and private utilities can provide the necessary data.
- This data is added to the model community.

c. What are the potential growth rates:
- Of the community?
- Of the energy needs to meet that growth?

(The student projects a theoretical growth and calculates the additional power needed.)

d. Now, with this hypothetical model, the student analyzes the total community energy picture.
- Total demand to be planned for: Present demand plus projected growth demand.
- Total demand less current supply equals energy growth that must be produced.

materials:



implementation:

Activity:
(continued)

e. At this point the student projects a percentage of the growth demand that will be provided by electrical generation. (Perhaps the same percentage as is supplied currently. This figure would be readily available from most local power utilities.)

f. Knowing how much energy must be sited for, the student now constructs a model that shows as many possible sites for potential plants as he can now locate. (No attempt is made at this point to evaluate the sites. Every possible site is included.)

g. The complete model now shows:
- How much power is needed.
- Where it will be used.
- The existing transmission and generation system.
- Potential sites for expansion of the total system. Using this model the student analyzes the total system and generates a proposed list of sites on a priority basis, using adaptability to the present system as the main criterion.

This completes that category of the siting process know as System Planning; i.e., so far, largely the Enterprise Outlook.

3. Safety is the category of siting that deals with meeting federal, state and local laws pertaining to the public welfare. It includes an analysis of all possible contingencies, e.g., earthquakes, floods, fire, tornadoes, radiation hazards, etc.

a. Referring to the hypothetical model, the student will prepare an analysis of each potential site with the following factors as criteria:

materials:

implementation:

Activity:
(continued)

- Flood possibilities.
- Landslides.
- Tornadoes or hurricanes.
- Tsunamis (tidal waves).
- Avalanches.
- Earthquakes.
- Earth faults.
- Subsidence (soil settling).
- Disposal of waste products.
- Possible air or water pollution.
- Radiation accidents.
- Noise control.
- Plant appearance (visual pollution).
- Other.

4. Engineering refers to considerations of the site in light of

   a. The student will evaluate the proposed sites with regard to negative and positive building characteristics. Will it be necessary to drain a swamp? Is soil stability a factor? Would service roads be prohibitively expensive? Is large-scale transportation available? Is there storage area during construction? Is skilled labor available?

   b. Based on these analyses, the student draws up a priority listing of sites in rank order of suitability with regard to engineering.

5. Environmental factors are considerations of the positive and negative aspects of particular sites with regard to effects on the environment.

materials:

Content knowledge:

- The student lists and describes each of the six siting factors with 100% accuracy within a thirty minute period.
- The student lists and describes the major viewpoints on siting with particular attention to the weight each group places on each factor (e.g., the societal viewpoint places great stress on safety). This should be a comprehensive statement with no time limit.
- The student lists two agencies on each of three governmental levels and describes the interest each has in siting, with 100% accuracy and within a fifteen minute period.

Skills attainment: So many skills are involved in this exercise that the evaluator can choose to check any number of them or some particular few that relate specifically to a program. For example: The skills involved in data gathering would include:

- Determining information needed.
- Locating appropriate sources.
- Arranging appointments.
- Interviewing resource people.
- Taking notes.
- Covering all significant aspects of a problem: Who? What? When? Where? How? and Why?
- Report writing.
- Library research .... etc.

implementation:

Activity:
(continued)

a. The student analyzes each potential site and considers possible environmental effects such as:

- Will this plant adversely affect the heat balance of the area?
- Will humidity changes significantly affect the climate of population centers or agricultural regions?
- Will the carbon dioxide content of the atmosphere be changed?
- Are there background radiation changes of significant proportions to be considered?
- What is the highest and best use of this land?
- What aesthetic considerations should be considered? Will a plant here enhance the beauty of the area or will it materially detract from it?
- Are there recreation losses or benefits to be considered? Will a storage lake have a positive recreational effect or will it cover or otherwise damage existing assets?
- What is the possible effect on resources and wildlife? Will it destroy animal shelters, cover valuable timber or mineral production areas?
- How about possible cultural effects? Are there historical points of interest or artifacts to be considered? (The endangered monuments upstream from the Aswan Dam provided a good example of this.)
- What would be the probable effect on local air and water?

materials:

- Presentation. Each student can be evaluated on his/her presentation of the site analysis. Possible criteria might include:
  Speaking techniques.
  Accuracy of statistics.
  Thoroughness of coverage.
  Persuasiveness.

Valuing: Each student will be given an opportunity to formulate new values, strengthen or re-assess old values, and consider the pros and cons of others' values through a series of carefully structured multiple-choice questions or categorization exercises. For example:

- Arrange the following in rank order of importance from (1) most important to me to (5) least important to me.
  Power to maintain our present standard of living against rising population.
  The protection of the public from the remote but possible danger of a large-scale nuclear accident.
  Protection of the air and water from pollution related to increased power generation.
  Cheap energy is possible with the purely enterprise outlook.
  A landscape free from powerlines and switching complexes.

or .....

implementation:

Activity:
(continued)

b. Based on these factors, the student draws up a priority listing of sites in rank order of suitability with regard to effect on the environment.

6. Institutional factors are those aspects of siting that deal with local, state and federal regulations and procedures that must be met to license and operate a power plant. They usually fall into two categories- construction and operation.

a. The list of agencies possibly involved is staggering. The student should select, say one or two agencies from each level of government, contact them, and determine their interests in siting a plant. The data collected could take the form of written reports. See the attached list of possible agencies to contact.

b. Based on these reports, the student draws up a priority listing of sites in rank order of suitability with regard to obtaining the necessary permits, clearances and licenses. (Obviously, the student's list will be based on limited research and, hence, not nearly complete.)

7. Economic factors are viewed from two basic vantages:

a. The Enterprise Outlook, i.e., what site offers the greatest dollar return on capital invested.

b. The Societal Outlook, i.e., which site provides maximum service at minimum cost?

c. The student is to draw up two lists, ranking the sites on an economic basis from the enterprise outlook and from the societal outlook.

materials:

- It is more important that:
  the present population continue to benefit from our technological discoveries, using the finite resources available for as long as they will last.
  The rights of the unborn population be protected against complete depletion of finite resources, even at the cost of changing present lifestyles.

Social Action (Participation): Siting actions become, and will continue to be, a regular feature of public life. Students should be encouraged to personally involve themselves in the actual process. This is a golden opportunity for full, meaningful participation in the democratic process. It should be possible to either simulate a siting hearing or to arrange a field trip to a local hearing.

implementation:

Activity: (continued) 8. Site Choice: Finalization.

a. The final phase of this exercise is to gather all of the priority listings and synthesize the various results. For this exercise it is probably advisable to give the factors equal wieght (i.e., safety ranks equal to economic factors, etc.).

b. The site choice now becomes a matter of statistical analysis (theoretically). The students sum up their analysis of the total situation by presenting a rank ordered list of potential sites, listing outstanding assets and liabilities of each.

SUGGESTED CAREER EDUCATION ACTIVITY:

Given the opportunity to participate in plant siting activities, the student will be able to identify the variety of occupations associated with the six factors of

materials:

SUGGESTED ASSESSMENT PROCEDURE:

Given the opportunity to successfully complete a number of related activities, the student will be able to demonstrate an understanding of the factors involved in siting a plant by presenting a site review model based on factors of siting as they apply to a given situation.

Developed by: L. B. Knight
Everett School District
Everett, WA

GOVERNMENT AGENCIES

LOCAL GOVERNMENTAL AGENCIES

City Council
Planning Commission
Board of Supervisors
Zoning Board
Water Quality Control Board
Air Quality Control Board
Health Department
Water District
Fire Department
Building Department
Flood Control Districts
Sanitation Districts
County Road Department
Department of Parks and Recreation
Metropolitan and District Clearinghouses
Utilities Coordinating Committee
County Commissioners
City Art Commission
City Department of Airports
City Bureau of Street Maintenance
City Department of Public Utilities and Transportation
City Police
Civil Defense
City Department of Public Works
Sheriff
Boards of Architectural Review
Railroad District

STATE GOVERNMENT AGENCIES

State Division of Lands
State Regulatory Agency (Public Utilities)
Water Quality Control Agency
Air Quality Control Agency
State Department of Forestry
State Department of Fish and Game
State Highway Commissions
State Department of Public Health
State Department of Conservation
State River Commissions
State Reclamation Board
Division of Aeronautics
State Labor Bureau
State Labor Commissioners
State Engineer
State Public Utility Commission
State Environmental Quality Commission
State Historical Society
State Division of Mines
State Clearinghouses
State Geothermal Resources Board
State Resources Agency
State Division of Oil and Gas
State Highway Patrol
State Legislature
State Fire Marshal, Boiler Inspector, and Engineer
State Lands Commission
State Water Agency
State Department, Beaches and Parks
State Navigation and Ocean Development Department
State Power Plant Siting Committee
State Division of Industry Safety
State Department of Agriculture
State Department of Commerce
State Public Utility Commission
State Board of Geology and Mineral Industries
State Industrial Commission
State Law Enforcement Agency
State Building Department

FEDERAL GOVERNMENTAL AGENCIES

Federal Power Commission
United States Army Corps of Engineers
United States Forest Service
Federal Communications Commission
United States Department of the Navy
United States Department of the Air Force
Bureau of Indian Affairs
Veterans Administration
United States Geological Survey
Bureau of Sport Fisheries and Wildlife
United States Coast and Geodetic Survey
United States Department of Agriculture
Department of Housing and Urban Development
Environmental Science Service Administration
National Marine Fisheries Research
Advisory Council on Historic Preservation
Bureau of Outdoor Recreation
Federal Aviation Administration
Bureau of Land Management
United States Coast Guard
Bureau of Public Roads
United States Department of the Army
National Park Service
General Services Administration
Environmental Protection Agency (Water Quality)
National Oceanographic and Atmospheric Administration
Public Health Service
Atomic Energy Commission
Council on Environmental Quality
United States Department of Defense
United States Department of Commerce
Department of Transportation
Soil Conservation Service
United States Secretary of the Interior
Department of Energy

title: "The Alaska Pipeline: An Energy Dilemma"

impacts

concept: Conflicts over ecologically sound practices and aesthetic judgments will involve trade-offs if they are to be resolved.

objective: Given the opportunity to read conflicting articles, the student will be able to recognize the issues involved in meeting our energy needs and protecting the environment.

time: 3-5 45 minute class periods

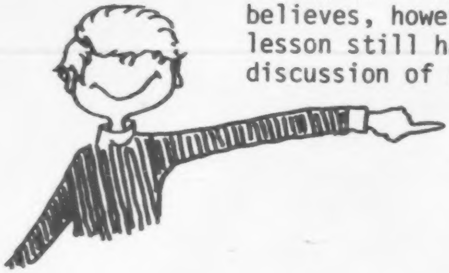
subject matter area: All

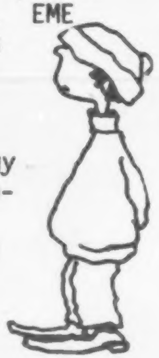
grade: 10-12

implementation:

Activity: 1. Students should be given the article in favor of the Trans-Alaska Pipeline. The first part of the period or preceding period should have been spent on the use and importance of oil in our society. The class should be told to make a list of the arguments used to advocate or defend the pipeline.

(EDITOR'S NOTE: The Alaska Pipeline is now an accomplished fact. EME believes, however, that this lesson still has value in a discussion of the tradeoffs involved in meeting energy needs and protecting the environment.)





materials:

Attached articles:
"The Case Against the Trans-Alaska Pipeline"
"The Need for the Trans-Alaska Pipeline"

Suggested articles:
Pro-Trans-Alaska Pipeline:
- "The Environment, Alaska-Oil and the Environment" and "Oil From the Arctic," write to Alyeska Pipeline Company, 1815 South Bragaw Street, Anchorage, Alaska 99504
- Write to Exxon Corporation. 1251 Ave. of the Americas, New York, New York 10020
- Write to Atlantic Richfield, 717 5th Avenue, New York, New York 10022

Anti-Trans-Alaska Pipeline:
- "Unsafe at Any Width--The Trans-Alaska Pipeline," Robert Sherrill, *Nation*, June 11, 1972, page 745

activity no. 10

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implementation:

Activity: (continued)

2. The second article should be distributed. (I'd suggest that the class not know at the distribution of article #1 that a second article will be given out.) The class might discuss the arguments in the initial article before the second one is read if this is deemed to be desirable. Again, the students should make a list of the objections to the pipeline. A column approach, juxtaposing arguments, might be helpful. An objective review of the arguments would be constructive to insure that everyone is now on equal terms.

3. Discussion of the decision to build the Trans-Alaska Pipeline should take place. A large circle teacher-directed session or small student groups composed of those supporting and opposing the pipeline may be used. The overriding issue of meeting our energy needs vs. protection of our environment should be stressed as well.

Optional Activities:

1. Students might be assigned an essay on the question, stressing their use of argumentation to support their position. This would occur after either Day 2 or 3.

2. The film, "Prudhoe Bay - Or Bust," is a well-photographed and effective rebuttal to construction to the pipeline supporters. It runs about 25 minutes and might be used to visually demonstrate the objections to the project. Alyeska Pipeline Company also has a similar length film supporting the project. These might be used prior to the articles.

materials:

(continued)

- "Arctic Pipeline," Quincy Dadisman, Nation, October 2, 1972, page 262
- "That Unstoppable Pipeline," Thomas Brown, N.Y. Times Magazine, October 14, 1973, page 34

Film:

"Prudhoe Bay - Or Bust," rental $11.50, Indiana University, Audio-visual Center, Bloomington, Indiana 47401

implementation:

Activities: (continued) 3. Additional articles, listed in the Materials section, can be obtained for more in-depth research and possible debates by selected class members.

Teacher comment: The teacher should obtain current information regarding the Alaska Pipeline and include this in the lesson.

SUGGESTED CAREER EDUCATION ACTIVITIES:

Given the opportunity to identify three occupations of interest, the student will be able to list the names and addresses and phone numbers of all local persons or groups to which the student could apply for work in the selected occupations.

materials:

SUGGESTED ASSESSMENT PROCEDURE:

Given the opportunity to read differing opinions as presented in two articles, the student will be able to participate in a class discussion dealing with the issue of meeting our energy needs and protecting our environment.

Developed by: Elliott Cheap
Everett School District
Everett, WA

Revise[illegible] Duane K. Altig

THE CASE AGAINST THE TRANS-ALASKA PIPELINE

Near Prudhoe Bay in Alaska lies an underground petroleum ocean as large as Massachusetts. Estimates put it at 10-40 billion barrels of oil. With strong Nixon administration support, the Congress has authorized the building of a 3.6 billion dollar pipeline which would stretch nearly 800 miles. This will be the largest private construction project ever undertaken. Unfortunately, construction of the pipeline may destroy or damage much of America's last remaining wilderness. The pipeline will cross the entire state, north to south. By splitting Alaska, it will for all practical purposes stake out America's forty-ninth state as the private domain of oil companies. Only about 10% of U.S. lands are still wilderness, and nearly all of this is in Alaska. More priceless than the oil itself is this wilderness; once it is gone, it will be gone forever. Ultimately, the oil companies will probably win; big corporations usually win consumer battles.

The discovery leases to Prudhoe Bay were granted by the federal government in 1964--well timed for oil company contributions to Lyndon Johnson's presidential campaign. In 1969, a lease auction brought Alaska nearly one billion dollars. Three major oil companies (British Petroleum, Exxon and A.R.C.O.) participated in the decision to build the pipeline. If it had not been for environmental groups, the oilmen would have carried away Alaska four years ago. So cocky were the companies, they bought $100 million worth of pipe, now costing them $5 million a month simply to fight rust.

Environmental and other organizations raised numerous objections to the pipeline. These groups are still convinced that the project entails far too many dangers, anyone of which might do irreparable damage to Alaska's environment.

Most of the objections environmentalists raise center on the possibilities of accidents after operation begins. Any spill in the Arctic would spew black crude oil over the landscape, killing almost everything it touched. In milder climates, a break in the pipe would result in a spill where the disaster would persist for months. In the Arctic it would last for centuries. Most methods for cleaning up a spill would not work in sub-zero weather. Further, the microorganisms that remove the last traces of an oil spill work only in warm weather.

Earthquakes and landslides will probably pose the greatest threat to the pipeline. Every year Alaska has more than 1,000 earthquakes; most of these are slight, but the pipeline would cross three faults, where two dozen significant earthquakes have been recorded in this century. Any point along the sourthern two-thirds of the proposed pipeline route could be subjected to an earthquake of magnitude greater than 7.0 on the Richter scale "...and in some areas earthquakes of up to 8.5 magnitude should be anticipated." (The Alaskan earthquake of 1964 which cost $500 million in damage and caused a tidal wave that wiped out the old town of Valdez, had a magnitude of 8.5. The energy released by that earthquake was twice as great as the San Francisco quake of 1906.) The companies say they have designed an earthquake-proof pipeline. Opponents say that this is impossible.

Aside from quakes, much of the ground along the pipeline route is highly unstable. Landslides could be commonplace, and they would cause pipeline leaks and ruptures. "In the event of a pipeline rupture, 14,000 barrels of oil could leak out during the time required for pump station shutdown and valve closure. After shutdown and valve closure, up to an additional 50,000 barrels of oil could drain from the pipeline at some localities." With smaller leaks, as much as 750 barrels of oil could be lost every day without being detected.

Some argue that the nature of Arctic soil will simply cause the pipe to rupture on its own. In the Arctic the topsoil freezes every winter and thaws each spring. But underneath it lies permafrost, which is composed of frozen water, sand, soil and rock. This offers a good base for construction if it can be kept frozen. Building a pipeline presents a serious problem. Oil is hot--150° or warmer--as it comes from the ground. As it passes through the pipe, the heat would be given off, penetrating into the ground. The water in the permafrost would melt. As this occurred the pipe would begin to sag. Eventually it would break and create a disastrous spill.

The marvelous plant and wildlife of Alaska faces the greatest threat from the construction of the pipeline. Most of the controversy has centered around the caribou. These are migratory animals similar to elk. They inhabit most of the areas the pipeline will cross. They wander around Prudhoe Bay and appear little troubled by the operations. But no one is sure how they will react to machinery charging over the tundra. If their migratory patterns are disturbed, the survival of the species may be threatened. A pipeline elevated to prevent permafrost melt will pose a barrier to their movements. The oil companies say that ramps will be built to allow them to cross. However, the only extensive study conducted, using a simulated pipeline, showed that the caribou would not use the ramps; this is a fact the Interior Department chose to ignore. If the pipeline is built, it may spell extinction for this most remarkable animal. Since the pipeline will cross 350 streams, there will be a danger of major water pollution. If the pipe crosses above the rivers any spillage will pollute the streams for miles. Burying the pipeline would mean distrubing gravel beds, the greatest spawning sites for many fish. Once the oil reaches the port of Valdez, the danger of spill still will remain. Basing an estimate on the experience of the worldwide tanker fleet, the Alyeska fleet would have an average of 1.7 collisions or groundings each year. Experts foresee a total of 613,000 barrels of oil washing ashore or ruining oyster beds and killing salmon. With the world's hungry increasingly becoming dependent on the harvest from the oceans, is the danger really worth taking?

The devastation which construction will cause will be immense. Many miles of pipe will be laid underground. Ditches to receive the pipe would be seven feet deep; while the ditches lay open, they would be death traps for moose, caribou and bear. Past experience tells us how this precious land would be affected. In 1970 a road was built from Fairbanks to the North Slope, a distance of 400 miles. It was an engineering disaster. After the first winter it resembled a drainage ditch and was impossible. In the past, oil companies have shown contempt for the land; this is not a part of what Exxon wants you to know. Tracks left by a bulldozer in 1969 now are six feet deep due to the sun's heat on the broken permafrost. The pipeline would require quarrying about 70,000 cubic yards of gravel. Where this is dug, massive sores would be left in the tundra.

The oil companies have been quick to argue that disrupted land will be revegetated (replanted). Yet, this may not be possible. Plants grow slowly in the Arctic. Pine trees 200 years old may be only 12 feet tall. Grasses can be replanted. But even under the best conditions, the scars will show for centuries

The Prudhoe Bay oil field is expected to cover 880 square miles, and while that is only .15% of Alaska's land area, it is enough, coupled with the pipeline and roadways, to leave indelible evidence of man's presence. Gouged, smeared, torn, Alaska's wilderness affected by the project would be irreversibly and irretrievably harmed.

THE NEED FOR THE TRANS-ALASKA PIPELINE

There are 205 million persons in this country, each using an average of three gallons of oil a day. At least 75% of our energy needs are supplied by petroleum. We also use oil in medicine, paints, fabrics and thousands of other products. About one-fourth of our oil comes from other nations. Our use of foreign oil has been increasing while our domestic reserves have decreased. But in 1968, a major oil discovery was made in a barren North Slope area of Arctic Alaska. The confirmation well showed large reserves of oil. These reserves have been evaluated as one of the world's great petroleum deposits. Estimates have ranged upwards of ten billion barrels of recoverable oil.

The discovery is important to our nation--a matter of supply and demand. Both industry and government sources place current domestic crude oil demand at fourteen to fifteen million barrels a day. Domestic production which, excluding Alaska, is currently less than ten million barrels per day, peaked early in this decade and then began to decline. North Slope production will help to bridge this gap and lessen the United States' dependency on overseas imports from areas of political instability.

Once the oil was discovered, the crucial concern was moving the crude oil to market. In July, 1968, Atlantic Richfield Company, Humble Oil and Refining Company and BP Oil Corporation began preliminary studies to determine the feasibility of a pipeline and to investigate possible routes and terminal location. Alyeska Pipeline Service Company was formed by the owner companies in August 1970, as a corporation to assume the responsibilities for the TAPS project.

The proposed pipeline will reach from Prudhoe Bay on the North Slope to Valdez; the oil will be shipped by tanker to refineries in the lower 48 states. The pipeline will be the single largest construction project ever undertaken by private industry. The job will take at least three years to complete and will cost over a billion dollars.

ENVIRONMENT:

Nearly everyone now realizes that man has for too long taken Nature for granted. Land, air and water have been exploited, fouled and scarred.

In the past, environmental considerations have frequently played a somewhat subordinate role in the planning of huge construction projects. In the case of this pipeline, environmental factors have been and will continue to be uppermost in priority.

The challenges involved in a project of this size would be rigorous in a temperate climate. Beyond the relatively manageable difficulties of constructing an 800 mile pipeline over three mountain ranges, there is the extreme remoteness, an incredibly harsh climate, extended periods of darkness, areas of high seismic activity, permafrost and a delicate ecological balance.

It will take a great deal of care and a great deal of money, but we are sure that this pipeline can be built without severe damage to the land, the people, or the wildlife. Environmental disturbances will be avoided wherever possible, held to a minimum where unavoidable and repaired to the fullest practicable extent.

WILDLIFE:

Will the pipeline seriously threaten wildlife? No! Surveys indicate that not a single species will have a significant portion of its habitat endangered.

Environmentalists have argued that the pipeline will block the migration of great caribou herds, thereby threatening the survival of the species. However, little danger will be posed to these animals. First, while 30,000 caribou may at some time use the same mountain pass as the proposed pipline, most of the pipeline will be buried in these areas and crossing will be no problem. Second, most surface stretches of the pipeline will be short enough to allow the animal to simply follow the line for a few miles and cross it as it again dips underground. Lastly, where sections may be too long, special ramps will be provided. Some feel that the caribou would not use these ramps. Yet, experience at Prudhoe Bay indicates that caribou are unconcerned by man's presence. The animals cross airstrips and roads without difficulty. Alyeska conducted experiments in 1971 to find out how caribou respond to obstacles and crossing conditions. A simulated pipeline was set up. The information from this experiment will be used to develop the most satisfactory crossing facilities.

What about other animals? Bears should have no problem going over or under the line. Sheep will have no problem since the pipe will be buried in most of their ranges. While the pipeline will cross rivers containing fish, it will usually be buried beneath the river bed, making contamination very unlikely.

PLANT LIFE:

Once the pipeline is built, the crews will clean up the area and disturbed vegetation will be replanted with fast growing grasses. Through reseeding and fertilizing, an area will have the vegetation restored. The University of Alaska has tested twenty grass species along the proposed site. Experience proves that we can successfully revegetate the pipeline right-of-way.

ENGINEERING:

Building the pipeline will present certain engineering problems. As the oil passes through the pipe, heat will be caused by friction. Much of Alaska is permafrost: frozen soil, rock and water. If the line were buried in this permafrost, the heat would cause the ice to melt and allow the pipe to sag and perhaps break, resulting in an oil spill. To avoid this danger, over one-half of the pipeline will be raised. Some have argued that this would make possible damage from earthquakes. However, the pipe will be 1/2" thick and capable of stresses equaling 70,000 pounds per square inch. The system has been designed to survive the most severe earthquakes ever to rock Alaska. Beyond this, safeguards such as automatic cut-off valves will be built into the system. Two computers will monitor lines on a 24-hour basis. Any break which did occur would rapidly result in a shut-down operation. Resulting damage to the environment would be localized, minimal and likely not permanent.

CONCLUSION:

A nation which runs on oil cannot afford to run short. This is the dilemma which we are now facing. If we are to meet our nation's energy needs and do so without an overdependence on foreign sources, we must develop the North Slope in Alaska. Already the delays have meant that it will be 1978 before the first oil will flow through the Trans-Alaska Pipeline. Haven't we waited long enough?

title: "Traditional Values And Energy-Use Problem Solving"

impacts

concept: Efforts to regulate energy producers and users require energy, economic allocation and political effort.

objective: Given the opportunity to collect the necessary materials, the student will be able to use information from decision-making groups (planning boards, city council) to apply traditional values used in the decision-making process and describe their impact upon energy-use problem solving.

time: 3-4 45 minute sessions

subject matter area: Language Arts, Social Science

grade: 10-12

implementation:

Activity:

1. Students keep a collection of news articles about local decision-making processes concerning all environmental issues, especially the reactions of local leaders to federal-state-regional programs.
2. Students are instructed about the historical bases of the traditional values of individualism, privacy, fear of big government, local control, free enterprise and so on. Now our vast complex society needs to re-evaluate these ideals in light of the resource-use control programs that will soon be necessary.
3. A field trip to a local council meeting, or a comparable body, would enhance understanding of the process.

SUGGESTED CAREER EDUCATION ACTIVITY:

Given an opportunity to discover the values related to work, the student will be able to relate personal values with the values of work.

materials:

SUGGESTED ASSESSMENT PROCEDURE:

Given an opportunity to collect newspaper articles related to environmental issues, and obtain the background knowledge of historical base of the traditional values, the student will be able to make judgments or generalizations about the traditional values as they obstruct the formulation of sound, comprehensive energy policies.

Developed by:
G. Lass
Beaverton School Dist.
Beaverton, OR

activity no. 11

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title: "Special Interest Groups"

impacts

concept: Efforts to regulate energy producers and users require energy, economic allocation, and political effort.

objective: Given the opportunity to research the particular concerns of selected special interest groups, the student will be able to identify their impact on the regulation of energy producers and users.

time: Variable (depending on depth of student presentations)

subject matter area: Social Science, Language Arts

grade: 10-11

implementation:

Activities: 1. Students role play an interest group with its particular perspective on a valuable resource, such as land in relation to energy sources, discovery, exploitation and marketing.

SPECIAL INTEREST MIGHT INCLUDE:

a. Business and finance.
b. Energy and power concerns.
c. Organized labor interests.
d. Conservationists- Sierra Club, Friends of The Earth, etc.
e. Recreationists-hikers, fishermen, golfers, etc.
f. Real estate

2. Special interest-group descriptions and stereotyping are essential in this role-playing activity. The greater amount of preparation time would be devoted to clarifying these identities to the students.

3. Divide the class into small groups.

4. Have the students discuss or present to the class a dialogue that represents the views of interest groups as they might relate to a real situation in the community.

materials:

activity no. 12

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implementation:

Activities: 5. After the dialogue presentations, have the class
(continued) discuss the implications of special interest groups to the regulation of energy producers and consumers.

Optional: Guest speakers may be invited to the class to speak about the topic of energy regulations for producers and consumers.

SUGGESTED CAREER EDUCATION ACTIVITY:

Given the opportunity to explore several occupations of personal interest, the student will be able to identify the professional or other organizations associated with the members of the occupations selected.

materials:

SUGGESTED ASSESSMENT PROCEDURE:

Given the opportunity to role play the views of special interest groups, the student will be able to take part in a class discussion on the implications of the views of special interest groups in the regulation of energy producers and consumers.

Developed by: G. Lass
Beaverton School District
Beaverton, OR

Revised by: Duane K. Altig

title: "Pros and Cons of Energy Use"

impacts

concept: Some uses of energy are more threatening to ecosystems than are others.

objective: Given the opportunity to read differing opinions on the use of coal, the student will be able to recognize the trade-offs involved in any attempt at a solution to the problems of energy use.

time: 3-4 45 minute class periods

subject matter area: Language Arts, Social Science

grade: 10-12

implementation:

Activities:

1. Students should be given the article entitled "America's Black Gold: COAL." This supports strip mining. The first part of the period or preceding period should have been spent on the uses and importance of coal in our society. The class should be told to make a list of the arguments used to support greater utilization of coal and the use of strip mining.

2. The arguments in the first article should be discussed, and every student should end up with a common list. Then the second article should be distributed. (Suggestion: Do not tell the class at the time you are distributing the first article that a second one will be given out.) The class should then read the article opposing strip mining entitled, "Strip Mining and the Destruction of the American West." Again, students should list the arguments in the article. A column approach so that the issues are juxtaposed might be helpful.

3. Discussion of the probable increased use of strip mining should occur. A large circle teacher-directed discussion or small groups composed of those supporting and opposing the increased use of surface mining should be used.

THERE ARE TWO SIDES TO ANY ISSUE!

materials:

Attached articles:
"Strip Mining and the Destruction of the American West"
"America's Black Gold: COAL"

Suggested articles:

Pro-Strip Mining:
- "Coal's Comeback," Business Week, November 4, 1972, page 50.
- "Coal-Black Ace in the Hole," Newsweek, November 12, 1973, page 93.

Anti-Strip Mining:
- "Western Coal: Does the Debate Follow Irreversible Commitment?" Science, November 2, 1973, page 456.
- "Strip Mining," National Parks (mag.), July 1971, page 10.
- "Strip Mining and the Environment" Science News, May 1, 1971, page 297.

Pro and Con:
- "Great Western Coal Rush," Reader's Digest May 1971, page 104.

activity no. 13

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Activity No. 13 (page 2)

implementation:

Activities: (continued)

The overriding issue of meeting our energy needs vs. protection of our environment should be stressed as well.

Optional Activities:

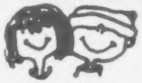
1. You may wish to go into more detail on argumentation and the proving of assertions. Students could be told to identify the defense of each argument in both articles as valid-invalid, proven-unproven, logical-statistical or expert-opinion type of proof. The use of flagrant emotionalism could also be identified.

2. Students might be assigned an essay question stressing their use of argumentation to support their position. This would occur on Day 2, 3, or 4. The topic could be either a defense or condemnation of strip mining, or a role-playing exercise could be employed. The student would represent a federal or state agency which has the power to authorize or veto new strip mines; the paper would then be written from that point of view. An additional option for an essay would be to inform the students that they must propose a reasonable compromise and then defend their solution to the problem.

3. A class debate could occur instead of, or in addition to, the written project.

4. Role-playing could be a valuable technique. Some students could represent a mining company, others, environmental groups, and the majority of the class could be legislators or bureaucrats who must decide how to proceed based on what occurs in the debate.

materials:



(continued)

Suggested point of resource:
The National Coal Association will be happy to provide information upon request. Obviously, the material is one-sided. Pamphlets and newsletters are plentiful.

FILMS:

"Black Coal, Red Power"
Indiana University
Audio-Visual Center
Bloomington, IN 47401

"There's Coal In Them Thar Hills"
Time-Life Multimedia
Distribution Center
100 Eisenhower Drive
Paramus, NJ 07652

"Strip Mine Trip"
Churchill Films
662 N. Robertson Blvd.
Los Angeles, CA 90069

implementation:

SUGGESTED CAREER EDUCATION ACTIVITY:

Given the opportunity to view a film on the mining industry, the student will be able to relate the required job skills viewed in the film with the students own level of skill development and outline the probable procedures to obtain the necessary skills.

materials:

SUGGESTED ASSESSMENT PROCEDURE:

Given the opportunity to read articles for and against the increased use of coal, the student will be able through discussion to identify the trade-offs involved in solving the dilemma between increased use and environmental protection.

Developed by: Elliott Cheap
Everett School District
Everett, WA

Revised by: Duane K. Altig

STRIP MINING AND THE DESTRUCTION OF THE AMERICAN WEST

The sign along the roadside says "Keep Kentucky Green." But for as far as you can see, there is very little to keep green. The scenery is a study in black and gray, carved in scars on what were once beautifully forested slopes. This is Letcher County, Kentucky. This is strip mining in the Appalachian Mountains. The scene is no different throughout most of eastern Kentucky, most of West Virginia, and huge sections of Pennsylvania, Indiana and Ohio. The coal companies refer to it as surface or open pit mining. But this is strip mining in the most terrible meaning of the word. The beauty and all too often the life has been stripped from the earth so that these companies can earn tremendous profits. Strip mining has affected all 50 states. The Interior Department estimates that 3.8 million acres across the U.S. have been surface mined. Currently, 150,000 acres per year are being destroyed by this process. This presently represents 48% of all coal production, up 13% from 1969.

The recent energy crisis has forced Americans to answer an important question In our hurry to meet our energy needs, will we allow the West to become ravaged by strip mining as well? The danger is great. Some 190,000 square miles of Utah, Arizona, Colorado, Wyoming, Montana and the Dakotas are underlain by coal. This represents an area greater than the combined size of Washington and Oregon. Already coal companies are making plans to recover the coal and thereby devastate some of our most beautiful and best grazing areas. The companies insist that for much of the coal, over 70 billion tons, the only way to obtain it is to strip mine. The seams of coal lie too close to the surface and/or are too narrow to permit conventional deep-shaft mining. However, since strip mining is the most inexpensive method, the companies are not disturbed by the need to surface mine.

There are several dangers in allowing the coal companies to carry out their plans. Foremost is the bleak destruction of the land which will result. Picturesque areas could never be returned to their original state. The farm and grazing areas might not be useful for decades. The coal companies are now trying to convince the public, as well as the government, that they are sympathetic to environmental needs. Company officials argue that the companies now spend enormous sums of money on repairing the damage that was caused. This process is called restoration or reclamation. However, a study conducted by over twenty of this nation's geological and botanical experts conclude that mining companies could never restore the land, in the sense of recreating former conditions. These scientists conclude that this would not be possible anywhere.

While some reclamation may be possible in the East, most experts feel that this might not be feasible in the West. The key to successful restoration is adequate rainfall. Most of the coal lies in dry or semi-desert areas. The scientists concluded that where less than 10" of rain falls yearly, there is an extremely low chance of recovery. Over 50% of the coal-rich areas receive less than this amount annually; therefore, if we allow strip mining in this region, the destruction caused might justify the naming of the land as a National Sacrifice Area.

A second threat from strip mining in the West is probable damage to agriculture. Our nation has recently experienced a shortage in many agricultural products resulting in large price increases at the grocery store - the most alarming came in the price of meat. Yet, some of this nation's best grazing areas would be either disturbed or destroyed. Further, if electrical generation plants and/or gasification facilities were built near the mining areas additional damage could be caused. As one Montana rancher wrote, "I live and run cattle

LARGE GROUP DISCUSSION INSTRUCTIONS (Continued)

8. After the presentations have been made, the audience consisting of all the members of the class not participating in the Large Group Presentation, votes. They vote not on the basis of which side did the best job, but vote for what they now believe about each of the proposals.
9. If the audience votes for your proposal, you each receive 15 points. If you lose the vote, you each receive 5 points for your efforts.
10. If the A Section is the first to make their presentation, they are followed the next day by B Section.
11. Following the Large Group Presentation, you should write a summation of your preparation plus any other written preparation and submit this to your instructor. He may award you from 5-30 points for your efforts.

NAME______________________________

CLASS AND PERIOD________________________

INDIVIDUAL POINT TOTALS

DATE	ITEM	POINTS AWARDED	BALANCE

REAL SELF DISCUSSION

(Date) (Name of Person Being Evaluated)

1. Frequency of participation (less than 3 times is poor, as is more than 6). Give 1-5 points.

   ____

2. Quality of participation (SD's - facts, incidents, quotes - should be used to back up generalizations for highest quality). Give 1-10 points.

   ____

3. Deductions for discourtesy (interruptions, senseless remarks, repetitions). Deduct 1-5 points.

   Minus ______

   TOTAL POINTS ____________

(Signature of Evaluator)

REAL SELF DISCUSSION

(Date) (Name of Person Being Evaluated)

1. Frequency of participation (less than 3 times is poor, as is more than 6). Give 1-5 points.

   ____

2. Quality of participation (SD's - facts, incidents, quotes - should be used to back up genralizations for highest quality). Give 1-10 points.

   ____

3. Deductions for discourtesy (interruptions, senseless remarks, repetitions). Deduct 1-5 points.

   Minus ______

   TOTAL POINTS ____________

(Signature of Evaluator)

Nuclear salvation or nuclear folly?

New York Times Magazine
February 10, 1974

By Ralph E. Lapp

Article from the New York Times has been removed by ERIC due to copyright law.

FUTURE

The Public Power Council
Presents...

Questions & Answers

Our Need for Electricity

1. **Why all the fuss about electricity? Isn't our present power supply adequate?**
No, it is not. For the past 30 years and more, the demand for electricity has doubled every 10 years to keep up with the needs of a population that doubles every 46 years.

2. **If the population doubles every 46 years, why does the use of electricity double every 10 years?**
The electricity used per person has been steadily increasing, both for modern conveniences (such as air conditioners, frost-free refrigerators, electric knives, toothbrushes, radios, television) and industrial and commercial uses.

3. **Why don't we just cut down on the conveniences?**
Significant conservation will *not* result by cutting down on conveniences alone, since such consumption is a small fraction of the total demand for electricity, as shown.

POWER FOR COMMON APPLIANCES
(in Watts)

Electric range	12,200	Laundry washer	280-510
Laundry dryer	4.850	Television set	230
Air conditioner (window)	1,560	Mixer	120
Dishwasher	1.200	Can opener	90
Toaster	1,140	Sewing machine	75
Iron	1,090	Tuner-amplifier	50
Refrigerator-freezer	320	Toothbrush	7

Residential	32%*
Commercial	22%
Industrial	42%
Other Uses	4%

*U.S. Averages

Thus, conservation of electricity must also be accompanied by conservation in these other areas of energy usage, such as transportation, space heating, and industrial process heat. Additionally, significant amounts of electricity may be required for purposes related to cleaning up the environment, such as recycling of wastes, mass transit, and sewage treatment.

4. **If we need more electrical power, why not just build more plants like we've been doing?**
Most of the electricity generated in the U.S. comes from burning coal, oil and natural gas. Oil, especially low sulfur content oil, will be in short supply by the year 2000, and natural gas by 2020, at present

growth rates in total energy consumption. Only coal and nuclear fuels have substantial reserves—300 to 400 years for coal and many hundreds of years for nuclear fuels (assuming the successful development of fast breeder reactors).

5. **What about water power, solar energy, and such sources?**
There are a number of alternative energy sources. The electrical energy they presently supply is as follows:

Coal	47%	Nuclear (uranium)	3%
Gas	23%	Tide, Wind, Solar, and Geothermal (volcanoes, hot springs and wells)	Nil
Oil	10%	TOTAL	100%
Water (dams)	17%		

Essentially all economic dam sites are already in use in the U.S. The number of substantial tidal basins is extremely limited. Windmills are unreliable, variable, and (like solar energy) require energy storage for periods of calm, or cloud cover and night. In addition, solar energy requires huge land areas, and the efficiency of converting it to electricity is low, making it too costly. The amount of geothermal energy may be greater than previously thought and is now being re-estimated. So far, however, it is known to be available in only a few areas, mostly places remote from where large amounts of electricity are needed. The reliability of the energy flow from the earth is still an unanswered question, and only small and inefficient plants have been possible.

6. **If coal resources are adequate for several hundred years, why can't we just mine more coal and use it for the production of more electric power?**
There are several reasons. First, many large cities now require the use of low-sulfur coals, and the supply and distribution of such coals is limited. Other factors include: increasing costs of mining; laws requiring restoration of mined lands, especially strip mines; and increased safety regulations. Additionally, coal must serve as a future source of hydrocarbon derivatives, replacing those currently produced from oil and gas. Finally, it is a major source of air pollution.

7. **What about "fusion" that we hear so much about lately?**
Fusion (energy released by fusing together of light atoms in contrast to fissioning or splitting of heavy atoms) is another source of nuclear energy that is expected to result in smaller quantities of radioactive wastes. However, an experimental fusion device which generates more power than it consumes is not expected to be operated for at least five years yet. Like the nuclear (fission) reactor, it is expected to take about 25 years from the first reactor demonstration (1942) to the first economical power plant (1967). That means that fusion energy will probably not be available until about 2000, or later.

8. **Are you saying that for the remainder of the century we must depend primarily on coal and uranium?**
Yes, oil and gas will become too expensive as time goes on and should be conserved as sources of automotive power, chemicals, and medicines.

9. **Is it true that electrical generating plants are rather inefficient?**
Modern coal-fired plants are about 40% efficient, while the *average* coal-fired plant is only 33% efficient. First generation nuclear power plants (light water reactors) are about 33% efficient, while advanced reactors such as the High Temperature Gas-cooled Reactor and the future breeder reactors are about 40% efficient. Actually, electric generating plants are far more efficient in the use of the energy consumed than many devices in our common experience. Stationary gas turbines are about 30% efficient, diesel engines are 20 to 25% efficient, automobiles 16 to 18%, and gasoline lawn mowers 12%.

10. **What are the risks to the general public from a nuclear power plant?**
Risks associated with operation of a nuclear power plant fall into two broad categories. First, there is the risk of injury from exposure to the low levels of radiation as a result of normal radioactive discharges from the power plant. Second, there is the risk of injury as a result of an accident at the power plant. The consequences of a particular risk (i.e., the number of deaths) therefore, would depend both on the size of the risk and the number of persons exposed to the risk.

Radiation from Nuclear Power Plants

1. **What radiation comes from nuclear power plants?**
Radioactive materials are produced in solid, liquid and gaseous forms. The *solid wastes*, such as old pieces of radioactive machinery, used gloves, and shoe covers, are sealed in safe containers and shipped to licensed disposal areas for burial. This material generally has a very low level of activity. *Liquid wastes* include corrosion products, some fission products, and tritium. *Gaseous wastes* contain some gaseous fission products and also tritium.

2. **What is tritium?**
Tritium is a radioactive form of hydrogen that can be produced in reactors in several ways. It can be removed from the system as a liquid or a gas.

3. **What are corrosion products?**
Radioactive corrosion products result from chemical attack on metal parts in the reactor. These are periodically removed from the reactor in a liquid waste stream.

Biological Effects of Radiation

1. **If radioactive liquids and gases, in very small quantities, are normally released from nuclear power plants, what fraction of our total radiation exposure comes from these materials?**
The contribution from operating nuclear power plants is actually about .01 mrem per year, compared to 100-150 mrem per year received by the average American from the natural environment, and about 90 mrem per year (in 1970) from medical diagnostic exposure (primarily x-rays). If nuclear power plants were completely eliminated as radiation sources, the drop in average radiation exposure would barely be detectable. (see box at right.)

2. **In this country, has any member of the general public ever been exposed to a radiation dose in excess of the standards for the general population as a result of radioactivity from licensed nuclear power plants?**
No! No member of the public has ever been exposed to radiation levels above the annual dose limits for the general public.

3. **Some scientists have stated that 32,000 extra deaths per year from cancer will result from the radioactivity released from nuclear power plants. Is this true?**
This alarming statement made headlines but is false. Drs. John Gofman and Arthur Tamplin based their estimate on an improper use of existing data and the assumption that every person in the U.S. received 170 mrem per year from nuclear plants for 30 years—a physical impossibility. Using more realistic values for the current average population dose from nuclear power plants reported by the Environmental Protection Agency, the increased cancer death rate is about 1 death in 20 years.

1970 Radiation Exposures from Various Sources

Source	Percent of Total Population† Exposed	Annual Average Dose to Population Exposed (mrem/capita)	% of Total Exposure
Natural background	100	130	57.8
Medical diagnostic x-rays	100	90*	40.0
Fallout from weapons tests	100	5	2.2
Nuclear power	22	0.01	.044
		Total 225	100.0

*Equivalent to a genetically significant dose of 55 mrem/yr.
†205 million

4. **Why should we build nuclear power plants when the nuclear critic Dr. E. J. Sternglass states that children and fetuses are more sensitive to radiation and that the operation of nuclear power plants and reprocessing plants has increased the infant mortality in the areas where these plants are operating?**
The first part of the statement is true, but the second is false. Children and fetuses are more sensitive to radiation, and this is accounted for in permissible dose limits for the general population. Not only has Dr. Sternglass been unable to prove his claims of increased infant mortality, but over a four year period his methods of analysis and treatment of the data have been found to be erroneous by many statisticians, epidemiologists and public health officials. His claims have been repudiated by the Health Physics Society in a statement signed by all 14 living past-presidents; by the American Academy of Pediatrics, the Public Health Departments of California, New York, Michigan, Pennsylvania, Illinois, and the Environmental Protection Agency.

5. **Just what are the biological effects of radiation?**
There are two kinds of biological effects of radiation:
   (1) Somatic effects are those which impair the health or shorten the life of those exposed to radiation.
   (2) Genetic effects are those which are transmitted to the offspring of the exposed individual by mutations in the genes.

6. **What is the decrease in life expectancy due to the release of radioactivity from nuclear plants?**
No life shortening has been observed in humans, but it can be estimated from experimental effects in animals. The expected "life shortening" from nuclear plant effluents at their current release levels is estimated to be about 24 seconds. It is important to compare this with the life shortening effects of other agents shown in the table at right.

7. **How about genetic damage?**
The current *maximum* permissible radioactivity release levels from nuclear plants have been estimated to produce 24 genetic mutations per year in the U.S. But the rate from the *actual average dose* would be less than one mutation in four years. Since the spontaneous genetic mutation rate is 800,000 per year, the operation of nuclear power plants would increase this figure by less than 0.24, to 800,000.24.

8. **Even though the releases of radioactive material are low and dilute, isn't there reconcentration by some animals and fish?**
Yes, "biological concentration" can occur along the food chain. For example, dilute radioactive minerals from power plants can be taken up by algae. The algae is then consumed by zooplankton and the zooplankton by small fish in turn, being further concentrated at each step. The chain continues

COMPUTE YOUR OWN RADIATION DOSAGE

We live in a radioactive world. Radiation is all about us and is part of our natural environment. **By filling out this form, you will get an idea of the amount you are exposed to every year.**

	Common Source of Radiation	Your Annual Inventory
WHERE YOU LIVE	Location: Cosmic radiation at sea level Add 1 for every 100 feet of elevation 1 x ___ ___ Typical elevations: Pittsburgh 1200; Minneapolis 815; Atlanta 1050; Sequoia National Park 6400; Las Vegas 2000; Denver 5280; St. Louis 455; Yosemite Valley 4000; Salt Lake City 4400; Dallas 435; Bangor 20; Sacramento 30; Spokane 1890. (Coastal cities are assumed to be zero, or sea level.)	40 —
	House construction: Wood 35; Concrete 50; Brick 75; Stone 70	—
	Ground: U.S. Average	15
WHAT YOU EAT, DRINK & BREATHE	Water, Food, and Air: U.S. Average	30

HOW YOU LIVE	Jet Airplanes: Number of 6000-mile flights _____ x 4	_____
	Television viewing: Black and white – Number of hours per day _____ x 1 Color – Number of hours per day _____ x 2	 _____ _____
	X-ray diagnosis and treatment: Chest x-ray _____ x 100-200 Gastrointestinal tract x-ray _____ x 2000 Dental x-ray _____ x 20	 _____ _____ _____
	Compare your dose to the *U.S. Average of 200*	Sub Total ____ mrem
HOW CLOSE YOU LIVE TO A NUCLEAR PLANT	At site boundary: Number of hours per day _____ x 0.2 One mile away: Number of hours per day _____ x 0.02 Five miles away: Number of hours per day _____ x 0.002 Over 5 miles away: _____ None	_____ _____ _____

Total _____ mrem

One mrem per year is equal to: Moving to an elevation 100 feet higher
Increasing your diet by 4%
Watching one additional hour of black and white TV per day
Taking a 4-5 day vacation in the Sierra Nevada Mountains

Safety: Power Plant Safety Systems

1. Following the development of the atomic bomb, scientists and engineers were able to "tame the atom" for peaceful purposes such as nuclear power plants. Doesn't that mean that if a nuclear power plant goes out of control, it will explode like an atomic bomb?
No! A nuclear power plant cannot explode like an atomic bomb! Atomic bombs and nuclear power plants are fundamentally different. Bombs require the rapid bringing together of pieces of almost pure uranium-235 metal into a precise, compact shape. A typical nuclear reactor which generates the heat in a power plant uses a stationary uranium ceramic, *not the metal*, made up of only about 3 percent uranium-235. The remainder of the uranium is composed of uranium which does not fission. Furthermore, bombs are designed to disperse radioactivity while nuclear reactors are designed to contain the radioactive fission products. However, under some very special circumstances ordinary chemical reactions could occur, which might be rapid enough to be damaging.

2. Under what circumstances could such chemical reactions occur?
If there should be a very rapid (out-of-control) rise in the power generated or a blockage of coolant from the core, the metals in the core might melt and a rapid, energy-releasing chemical reaction between metal and water or steam could occur.

3. Would such a reaction destroy the plant and endanger the public?
No. The effects of potential chemical reactions have been anticipated and the plants have been designed to absorb them without any release of radioactivity or other adverse effects to the public. The chemical reaction and its effects would be contained within the 8-in. thick pressure vessel. The reactor core could, however, be damaged.

4. If a nuclear power plant cannot explode like an atomic bomb, just what are the hazards or accidents of concern to public safety?
The principal hazard to public safety is in the large amount of radioactive fission products that are created in the fission process in a nuclear power plant. Any accident or process that would result in a substantial release of them to the environment could be a threat to public safety.

5. But you said in answer to the first question that nuclear reactors are designed to contain the radioactive fission products. How is this done?
Each plant is surrounded by an area from which the public is excluded. The plants are located on sites separated from population centers by enough distance to provide meteorological dilution and dispersion of any radioactivity that could be released. In addition to the barriers designed into the plant structure (see box p. 28), there are many safety systems designed to operate and shut down the reactor if the plant begins to operate abnormally.

6. How about damage that could result from tornados and other severe storms?
Any parts of a nuclear power plant affecting public safety are designed to withstand without damage the effects of storms including tornados with wind velocities up to 300 miles per hour. Not only must the structures survive the wind and gust forces but the impact of debris and other missiles propelled by the storm.

7. Couldn't the fission products be released as the result of some accident that damaged one or more of the barriers?
Accidents have occurred but all of them have been contained. Accidents will happen in the future but almost all of them will be completely contained in the plants. A few accidents will be more serious and may cause plant damage and trivial release of radioactivity but no serious consequences to the public. Only rarely, perhaps once every million to ten million reactor-years of operation, a serious accident in which the barriers are penetrated might occur. Such safety prospects are the result of the way in which nuclear power plants are designed, licensed, regulated and operated.

8. What factors are considered in designing a nuclear power plant?
Since the beginning of nuclear reactor design, scientists and engineers have been asking themselves, "What if this happened?—or this *and* that?, etc." Each time the consequences of the hypothetical accident are analyzed and the plant designed so that there is no threat to public safety. This process is continued considering more and more improbable events or coincidences of events until a point is reached which is agreed by designers and all reviewers that the situation assumed is impossible or incredible, that is, beyond belief. The extremely unlikely, almost impossible accident just short of that point is termed the "design basis accident." A nuclear power plant must be designed with some safety margin to survive the design basis accident without endangering the public. This provides assurance that the plant has plenty of margin to withstand any accident which may actually occur.

9. Have there been accidents in any of the nuclear power plants?
Yes. There have been failures of equipment and human errors as would be expected in any complex system such as nuclear power plants. However, in every instance the safety equipment designed into the plant terminated the accident without injury to the operators or the public.

Safety: Emergency Core Cooling

1. The worst possible accident is a "loss of coolant" which is controlled by an emergency core cooling system. Has this accident occurred?
A loss of coolant accident has *never* occurred since nuclear power plants started operating in 1957.

2. But it must still be considered?
Yes. To ensure the safety of the public in any eventuality, the loss of coolant accident is considered. It is the most serious accident that has some slight chance of occurring. The only ways that coolant can be lost from a pressurized water reactor or a boiling water reactor is for the pressure vessel to rupture or for a main water pipe to break. It is the consensus of technical opinion that it is virtually impossible for the high quality, 8-12 inch thick steel pressure vessel to rupture. Thus, this accident could occur only by rupture of the piping. In the analysis no mechanism for causing this break is postulated; it is simply assumed that in the worst case a 2½ ft. diam. pipe with 2-in. thick steel walls breaks completely apart and the broken ends separate so that all of the cooling water and steam can be lost from the system through the two openings.

3. If this type of accident has never occurred, what are the chances of its occurring?
Estimates are based on experience with non-nuclear, high pressure piping systems. Failures by a major rupture of a pipe have occurred about once in 10,000 years of systems operation. However, nuclear systems operate at lower pressures—2500 lbs. per sq. in. (psi) instead of 3000-4000 psi—and are built to higher quality standards both in materials and workmanship. Quality control and inspection procedures are extremely rigid. So the chances of failure are much less than once in 10,000 years of operation. How much less? We don't know since it has never happened. Failures by a major pipe rupture are estimated to occur between once in 1 million to once in 10 million operational years. Of course, leaks and breaks of lesser magnitude, with lesser potential consequences, will occur more frequently.

4. Well, the demonstrated rate of one failure in about 10.000 years of systems operation may be good odds now when there are only 20 or so reactors, but will it be good enough when there are 100 or 1000 reactors so that a loss of coolant failure might occur somewhere every 10 or 100 years?
It is believed that the chances of a loss of coolant accident are acceptably low for now. Those chances will continue to be reduced as a result of on-going safety research and development and accumulation of experience. Meanwhile, pressurized and boiling water reactors are built with emergency core cooling systems (ECCSs) to further protect the plant, the plant personnel, and the public.

5. What is the ECCS and how does it operate?
Emergency core cooling systems are one of the engineered safeguards designed into reactors to ensure their safety. Their purpose is to maintain cooling of the reactor core in the event of a loss of coolant accident. They would operate automatically upon loss of coolant.
ECCSs differ depending upon the type of reactor. Current pressurized water reactors (PWRs) have a number of systems which flood the reactor core with water and prevent its heatup. Boiling water reactors (BWRs) have both a system which sprays water on the core from the top and another system which floods the core by injecting water from the bottom.

6. How likely is it for the ECCS itself to fail?
It is quite unlikely, since the ECCS is not a single system. Failure of a single subsystem or piece of equipment does not mean cooling capability is lost. On current PWRs, for example, the primary ECCS has duplicate, independent pipe systems each with two different water pumps, each taking electrical power from any one of three different supplies and two different sources of water. In addition, there is another system which will automatically inject water stored in tanks into the core using stored air pressure. Thus, several successive failures in parallel equipment must occur to prevent coolant from getting to the core. Since each of these systems is carefully engineered and periodically tested, they are very reliable. Thus, in addition to the once-in-a-million accident, three more unlikely failures are required before there is a hazard to the public, making the chances that a serious core heatup could occur negligible.

7. How are ECC systems tested on nuclear power plants?
Each part of the system is tested periodically up to the valves controlling entrance to the pressure vessel. It is assumed that delivery of the coolant to the core takes place from the pressure vessel inlet valves and this is the central issue of the current public hearings on the adequacy of the "interim core-cooling criteria." Testing, as required by the technical specifications for the plant, and the results of the tests (or any equipment failures or malfunctions) must be reported to the AEC. For example, at San Onofre, it is required to test valves, pumps, and all instrumentation signals of the ECCS during refueling and prior to restarting the reactor. Also, the safety injection, recirculating and refueling water pumps are tested monthly.

8. Okay! So the chances of a loss of coolant accident and ECCS failure are extremely small. But what if it happens, does that mean a disaster?
This is a matter of some controversy. Frequently opponents of nuclear power assert that a catastrophe would result and liken results, for want of any other knowledge, to those derived in a 1957 study (WASH-740) of a maximum hypothetical accident.

In that study it was assumed that half of the fission products in the core were thrown (remember, nuclear reactors cannot explode like atomic bombs) into the air as dust particles to be blown under the most adverse wind and weather conditions and deposited on the landscape and nearby population. As a result, it was estimated that the maximum would be 3400 killed, 43,000 injured, and $7-billion property damage. *However, present-day real nuclear power plants do not resemble in any way the study design and thus the conditions assumed cannot occur.* It is believed that an accident with consequences even resembling the severity of those indicated above approaches impossibility.

9. You said the ECCS is quite reliable, but I've read that the first time they tested it in Idaho it didn't work!
The Idaho test referred to was not a test of an actual ECCS as is frequently but erroneously stated. The test involved a 9-inch diameter pressure vessel with one set of inlet and outlet pipes. In the test a break in the inlet pipe was simulated and the attempt was made to inject water into the pressure vessel to cool the electrical heaters simulating the core. The water had to enter against the residual steam pressure as steam and water were being expelled through the break. It did not work. In contrast, reactor vessels are from 14 to 22 feet in diameter and usually have 2 to 4 sets of inlet and outlet pipes, each about 2½ feet in diameter (see photo). Water is injected through all the intact inlet pipes; in some systems an inlet pipe with a break is automatically sealed off from the ECCS source. Thus there are a number of intact pipes through which water enters the system.

10. Didn't the AEC order changes in the ECCS as a result of this test?
No. But following the test, the AEC reviewed the safety of water-cooled nuclear power plants with respect to their ECCS designs and operational reliability. It established a set of "interim criteria" which take into account the test results and which must be met until additional tests of the ECCS can confirm that the criteria are not necessary.

11. Hasn't there been some criticism of the AEC's interim criteria?
Yes. The reactor manufacturers and many utilities think the interim criteria are too conservative, while some environmental groups have criticized the AEC and their criteria for not being conservative enough. There is also a similar division among scientists and engineers within the AEC, universities, and national laboratories. As a result the AEC scheduled hearings which are now (Sept., 1972) in progress, in order that all views and evidence can be heard. From the record of the hearings and the recommendations of the Hearing Board, the Commission will revise the interim critieria, if necessary, to be adequately conservative to ensure the public safety.

TRANSPORTATION IN THE NUCLEAR FUEL CYCLE

1. Isn't it dangerous to transport nuclear fuels around the country? What are the associated hazards?

   There are two unique types of hazards which must be considered in the transportation of nuclear fuel: (1) radioactivity, and (2) criticality. Highly radioactive materials must be isolated from the environment, and personnel must be shielded from their radiations. Criticality is reached with nuclear fuel when the amount or mass of fuel assembled is increased until a critical amount is gathered together, at which point a self-sustaining nuclear reaction is started, such as occurs in a nuclear reactor.

2. Are both the radiation and criticality hazards present at all points in the fuel cycle?

   No. Transportation in the fuel cycle begins when the uranium ore is shipped from the mine to the mill. However, until the fuel has been used in the nuclear power plant, it is merely a naturally radioactive material and as such does not usually constitute a significant radiation hazard. Also, until it has been enriched in the isotope uranium-235, it cannot sustain a chain reaction except under very special circumstances which would never be present during shipping and thus, is no criticality hazard.

3. You said that once the uranium is enriched in U-235 care must be taken to prevent criticality. How can you prevent it?

   During handling and shipping of enriched uranium, the amount of contained material is kept well below the minimum critical value and the containers are held spaced apart one from another by a cage-like framework.

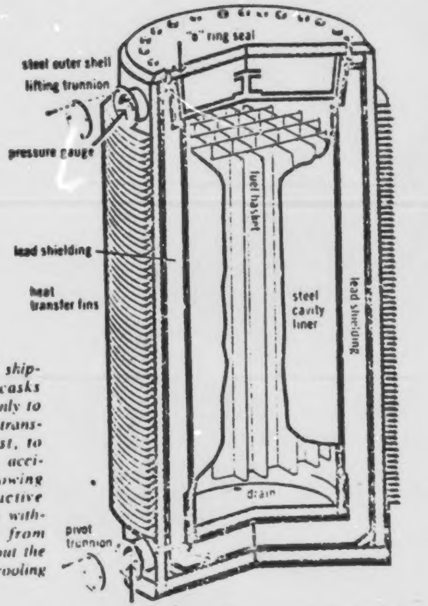
4. Is it true then that the only real hazards associated with shipping nuclear fuels is with the spent fuel and the fission product wastes?

   Yes. When the spent elements are removed from the reactor (normally after 3 or 4 years), they are stored at the reactor site for 3 to 4 months to permit decay of short-lived radioactivity. They are then placed in massive shielded shipping casks for transportation to the reprocessing plant. (See sketch at right.)

5. Have many accidents occurred to shipments of highly radioactive materials over the past 20 years? What have the consequences been?

   There have been accidents in transporting high level radioactive materials but this has resulted in no hazard to the public. Most accidents have been minor with no or only minimal damage to the vehicle or the shipping cask. In at least one accident, the truck was demolished and the driver killed. There was little damage to the cask and no leakage of radioactive materials.

6. What are these casks like and how safe are they? A typical cask is shown at right. Such casks are probably the most carefully designed shipping containers made by man. Casks like the one shown are made to contain fuel elements in a very strong steel shell (1 inch think) which in turn is surrounded by 8 inches of lead and finally by another 1¼ inch of steel to protect the lead. Radiant cooling fins are welded to the outer steel cylinder to remove the heat generated by the radioactivity in the fuel elements. The ends of the outer cylinder have massive flanges designed to protect the finned sides.



Typical spent fuel shipping cask. These casks are designed not only to withstand normal transport but, foremost, to withstand severe accidents without allowing escape of radioactive materials, and to withstand the heat from radioactivity without the need of external cooling systems.

Courtesy Atomic Industrial Forum, Inc

7. How do you KNOW the casks will survive an accident?

Cask designs are analyzed and tested by subjecting them to each of the following accident conditions, in sequence:

1. A 30-foot free drop on a flat unyielding surface with the cask oriented such that maximum damage will occur.
2. A 40-inch free drop onto the top end of a 6-inch diameter, 8-inch high milled steel bar with the cask oriented such that maximum damage will occur.
3. Exposure to a 1475°F fire for a 30-minute period, with no artificial post-fire cooling.
4. Immersion of the entire cask in water to a depth of three feet for at least eight hours.

After the cask has been through these four conditions it is tested for leakage and must be leak tight. The results of the tests are carefully reviewed to assure that the performance criteria established are met, before an AEC license or a Department of Transportation permit for the cask is granted.

8. What is the significance of this series of tests?

They represent a "design basis accident" which may be described as something like the following: a shipping cask aboard a train passing over a freeway is thrown off the train when the train is involved in a wreck. The cask lands 30 feet below on the freeway where a tank truck carrying jet aircraft fuel crashes into it and bursts into flame. The cask is enveloped in the flames which burn for 30 minutes, then it rolls off the road into a lake where it is submerged for eight hours before it is finally recovered.

9. But with the predicted increase in nuclear power, won't there be many more shipments and thus more accidents?

Yes, but most of the accidents will be minor ones, although serious accidents may clearly occur "sometimes." The objective is to make these as rare as possible and to assure that the cask remains sealed throughout any accident. As more fuel is shipped, the casks will be made even larger (from 50 to 100 tons) to minimize the number of shipments. The casks will be even more resistant to damage because of the additional shielding. Thus although there may be more accidents, there will be less likelihood of radioactivity release.

WASTE DISPOSAL

1. There seems to be a problem with nuclear waste disposal. Is it because there is going to be so much of it?

No. Although the quantity of nuclear wastes will increase in the future, problems of nuclear waste disposal are not related to the volume or weight of the wastes. The problem is that of disposing of radioactive fission products in such a way that they will remain isolated from the environment over the thousands of years they take to reach harmless levels. Nuclear wastes have been successfully stored since the beginning of the nuclear age 30 years ago, but in the U.S. more permanent disposal is being considered and controversy has arisen.

2. What is the nature and form of the nuclear waste?

The fission (splitting) of each uranium atom produces two new atoms (fission products) whose total weight is nearly equal to that of the original uranium atom. Further, the fission products are created in the nuclear fuel and remain there until the fuel assemblies are removed from the reactor. Since the fission products absorb neutrons needed in the nuclear chain reaction, thus slowing down the reaction, they must be removed or they would eventually stop the operation of the reactor. About two-thirds of the fissionable uranium (uranium-235) in the fuel is consumed before the fuel assemblies must be removed for reprocessing.

3. Why is the fuel reprocessed? Why not throw it away?

The spent fuel is first reprocessed to recover the valuable uranium-235 and plutonium which was generated from uranium-238. Recovery of the uranium reduces the cost of power production (by about 5%, or $3 million per year for a 1000-MW plant), conserves a valuable natural resource, and reduces the amount of mining necessary to replace it (by 20%) or the coal, oil, or gas fuel substitutes. (The cost of waste disposal has been estimated to be from 1½ to 2% of the cost of nuclear power.)

4. Is nuclear fuel reprocessing new and untried?

No, nuclear fuel reprocessing plants have been in world-wide operation for almost 25 years. In the U.S. there are one commercial and three government plants in operation, one commercial plant to commence operation in 1972, and another planned for 1974 operation. There are 13 other reprocessing plants in the world, principally in Europe.

Transportation in the Nuclear Fuel Cycle (cont.)

Waste Disposal

5. How are the fuel assemblies reprocessed?

The tubes which make up the fuel assemblies are chopped into small segments, the fuel pellets dissolved in strong acid, and the fuel and fission products chemically separated. The quantity of the solution containing the fission products will be somewhat larger than that indicated by the weights of fission products in the box. The heat from radioactive decay of the fission products is enough initially to boil the solutions; therefore, cooling must be provided.

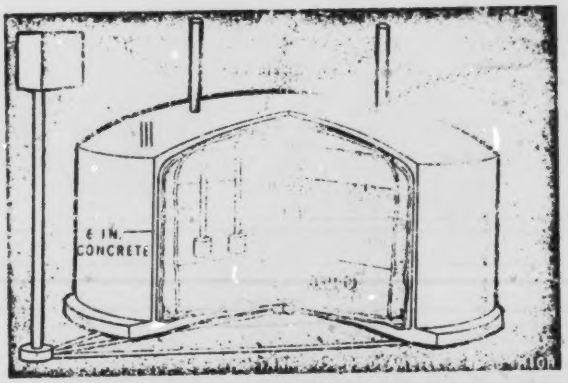
Fuel Consumption and Waste
(1000-Megawatt[1] Power Plant)

	Hourly	Daily	Annual
Fuel Consumption			
Coal	683,000 lbs.	8300 tons[2]	3,000,000 tons
Uranium	0.3 lbs.	7.4 lbs.	about 1 ton
Waste Production			
Coal (ashes)	68,300 lbs.	830 tons[3]	300,000 tons
Uranium (fission products)	0.3 lbs.	7.4 lbs.	about 1 ton

[1] 1000 megawatts is enough electricity for a city of about 1 million people
[2] equivalent to a 100-car trainload every day
[3] equivalent to at least a 33-car trainload every day (not including airborne wastes)

6. How are the waste solutions disposed of?

The highly radioactive waste solutions are contained in large underground tanks at the reprocessing plants, as shown schematically, where they may be stored for several years for the radioactivity and heat to decay to lower levels. Federal regulations require that the wastes be converted to stable solid form within five years of their generation and then shipped to a Federal waste repository within another five years.



Drawing of a modern double-walled waste storage tank. Both tanks are surrounded by a concrete structure.

7. What if a tank leaks?

A spare tank is always kept ready to receive the contents of a tank in case a leak develops. Modern storage tanks are doubly contained (see drawing) so that fluid leaking through the first barrier will not escape but will be detected and transferred to a spare tank.

8. Have tanks leaked and allowed radioactivity to escape to the environment?

At Hanford, Washington, 15 of 151 tanks have developed leaks at weld areas over a period of about 20 years, and some radioactivity has escaped into the ground. However, no radioactivity has reached or is expected to reach the water table.

Waste Disposal

9. How are the solidified wastes disposed of?

The solid low-level waste items from contaminated equipment and clothing are packaged, sealed and buried at government-owned sites. The solidified wastes taken from the storage tanks will be canned in leak-tight stainless steel, stored in shielded concrete vaults and monitored continually. These wastes are retrievable at any time for transfer to permanent disposal or for additional processing to extract components for useful applications that may be developed. The stored cannisters will be monitored for leaks and the contents transferred to new cannisters as required. However, in the U. S. more permanent disposal methods are under development. Disposal in rock salt formations is the method recommended for investigation by several review groups, including three different committees of the National Academy of Sciences, and is still the method which is favored after a 10-year study and testing program.

10. Has a salt bed waste disposal site been selected?

The Oak Ridge National Laboratory has conducted tests for the AEC in a salt mine near Lyons, Kansas, and considered using that mine for a Federal radioactive waste repository. Further investigation by the Kansas Geological Society determined that the Lyons site was unsuitable but that there are other potentially useful sites. As a consequence, the AEC has abandoned the Lyons site.

11. If the waste disposal methods are satisfactory, why has the current controversy over "nuclear garbage" risen?

There are probably many reasons. First, since the public has known little about the handling of the wastes during the past 20 years, it apparently believes that the technology of waste handling is still to be developed, and it has not been convinced that the wastes can be and will be safely isolated from the environment for the long periods of time required. Second, as with any wastes, people would rather have it in someone else's backyard. Few realize that large-scale waste storage facilities have existed uneventfully for a number of years in the following states: Washington, since 1943, 151 tanks plus two under construction (34 empty or containing solidified waste); Idaho, since 1953, 11 tanks; South Carolina, since 1954, 30 tanks; New York, since 1965, four tanks.

CALIFORNIA'S ELECTRICITY QUANDARY:

VOLUME III. SLOWING THE GROWTH RATE

Rand Corporation
Santa Monica, California
September 1972

The Rand Corporation is often described as a "prestigious think tank." Most of us are at least dimly aware of it as a high-powered outfit that specializes in heavy cerebration for the Pentagon and others. More formally and informatively, Rand describes itself as "a nonprofit public service corporation engaged in research and analysis on problems of the national security and public welfare."

REASONS FOR THIS STUDY

A variety of "solutions" have been proposed which range from measures as innocuous and ineffective as banning the electric toothbrush to those requiring sweeping legislative changes in present methods for planning and locating power plants. What is missing in most proposed "solutions" is an appreciation for the true dimensions of California's energy quandary. To acquire such an appreciation one must know something about the source of the problem.

One important source is the negative impact of man's activities on the environment. In the past, inadequate consideration has been given to these impacts. Decisions have too often been based upon analyses that failed to include all of the real costs of the actions considered-what the economist calls "external costs" or "externalities" because these costs are not included in the prices of goods and services...

Another source of today's-and tomorrow's-problems is that the demands for electricity (and other commodities essential to the smooth functioning of society) are growing exponentially. Yet ultimately the ability to supply these commodities is limited, because the supply of basic resources is limited. Economist Kenneth Boulding has likened the earth to a spaceship, noting that in a spaceship environment one cannot continue indefinitely with a "frontier" economy in which consumption continues as if resources were infinite. Resources on our spaceship earth are finite and must ultimately be conserved and recycled.

Conventional economic wisdom indicates that one need not worry about imposing control on growth when competitive price mechanisms acting in a free market are sufficient to maintain an equilibrium between supply and demand and when buyers and sellers can predict the future with high accuracy. But one can seriously question whether energy markets are sufficiently competitive or far-seeing to make the necessary adjustments soon enough.

ENVIRONMENTAL PROBLEMS

The attempt to expand California's electric supply system to meet future demands will result in several serious environmental problems. Among these are problems connected with the disposal and/or storage of high-level radioactive wastes, the questionable safety of present-day nuclear reactors in case of accident, land-use conflicts over the location of large power plants, inadequate resolution of existing air pollution problems, long-term climatological effects, and problems associated with the consumption of fresh water supplies.

The seriousness of most of these environmental problems depends both on the projected growth of electricity demand and on the kinds of power plants chosen (e.g., gas- or oil-fired or nuclear).

For a given mix of power plants, it is clear that other things being equal, environmental effects will be proportional to the number of power plants or to the amount of power produced. Air pollution, radiological hazards, thermal pollution, land-use conflicts, and aesthetic impacts in the year 2000 would be about three times less severe if the growth rate were slowed to 3 percent per year than they would be for the Conventional Utility Projection. (The "Conventional Utility Projection," says Rand is "based on submissions of electrical utilities to the California Public Utilities Commission.)

NUCLEAR SAFETY AND RADIOACTIVE WASTE DISPOSAL

The current controversy with regard to nuclear reactor safety centers upon what might happen if, in an operating power reactor, there were to be a sudden loss of coolant and at the same time the emergency (backup) cooling system were to fail...If the heat of fission is not removed, there is a danger that the reactor core would begin to melt, initiating a chain of events that could result in the release of radioactive fission products. Even most nuclear proponents consider this to be a "credible accident." The key question is whether or not the backup cooling systems are sufficient to control the accident.

Over the past year, it has been revealed that one of the key accident control systems, the Emergency Core Cooling System (ECCS) was designed by computer. Thus, lacking experimental testing, computer calculations are the only verification of ECCS effectiveness. When "sub-scale" tests were conducted last year, the models failed to function properly. In view of these revelations, the efficacy of all accident control systems on current and planned nuclear power reactors is in doubt.

It is not clear yet what will be required or how long it will take to design and fully test an adequate ECCS. In the meantime, although the necessary experiments on ECCS still have not been performed, reactor construction and plans for new construction continue. Other serious questions concerning the safety of nuclear reactors are also beginning to come to public attention. There are reports of unexpected fuel damage in several large power reactors. The problem appears to be due either to faulty manufacturing and inspection of fuel rods or to "generic flaws"-deficiencies that can recur repeatedly because they are common to present fuel element designs. In either case the consequences are serious and raise questions about the wisdom of future rapid expansion of nuclear power.

The largest reactor in normal operation today is around 800 MW. Only three are currently operating, two of them having first begun operations in 1971. Yet reactor manufacturers today are selling 1000-MW systems on which there is absolutely no operating experience.

Combine these difficulties with increasing reports of poor quality control and documented carelessness in manufacture, operation and maintenance of these complex nuclear systems and with potentially catastrophic consequences in case of accident, and one can question whether California should proceed with its nuclear future as currently planned. Or rather would it not be more prudent to employ a "go-slow" policy on future nuclear plans?

The second major controversy surrounding present nuclear power plans concerns the disposal and/or storage of radioactive waste. Periodically (generally once each year), part of the fuel of the nuclear reactor is removed and replaced with fresh fuel. The spent fuel is transported to a reprocessing plant where still usable uranium and plutonium is removed and eventually recycled. In the process, wastes that have been produced as part of the fission process are accumulated.

These wastes are highly radioactive and will remain extremely dangerous for tens of thousands of years. Because they are radioactive they generate heat and, in most present schemes for long-term storage, they must be cooled. The problem is that the wastes either must be disposed of or stored. (Rand footnote: "One scheme for disposal would involve sending the wastes into the sun or into deep space. This scheme appears to be both expensive and hazardous, with the greatest hazard resulting from potential accidents when the rocket is launched.") With present and foreseeable technology they (radioactive wastes) cannot be neutralized; nor at present do we know how to dispose of them in a permanent and safe manner. The AEC has proposed burying the wastes in deep, dry salt formations and abandoning them there. Initial experiments for such a system were to take place in salt formations near Lyons, Kansas. But the plans went awry when, after public opposition began to develop, it was discovered that a private company was engaging in solution mining of salt deposits nearby. In addition, it was learned that the dry salt formation might not be so dry as had been assumed, since numerous oil wells and dry exploratory holes had been drilled through them. The AEC has abandoned the Lyons site but not the salt storage scheme. As the matter presently stands, the problem of perpetual storage of high-level radioactive wastes is unresolved, and present plans call for above-ground temporary storage in concrete and steel vaults. Thus, while research goes on, reactors continue to be built, radioactive wastes accumulate, and the severity of the problem multiplies. Because of the radioactive waste problem the decision to rely on nuclear power generation as a prime and growing source of energy involves an essentially perpetual commitment of our society. Dr. Alvin Weinberg, Director of Oak Ridge National Laboratory, cites the view of Dr. W. B. Lewis on this matter: "Once man has opted for nuclear power, he has committed himself to essentially perpetual surveillance of the apparatus of nuclear power...."

This commitment may involve establishment of a "priesthood" that guards against inadvertent misuse or accident involving nuclear wastes. Thus, Weinberg continues, "We nuclear people have made a Faustian bargain with society. On the one hand we offer...an inexhaustible source of energy...but the price that we demand of society for this magical energy source is both a vigilance and a longevity of our social institutions that we are quite unaccustomed to."

With these remarks in mind, perhaps additional thought should be given to whether or not California should proceed with a growing commitment to nuclear power. Perhaps a "go-slow" nuclear policy for California would be more prudent until some of these basic difficulties with nuclear power systems are closer to resolution.

CALIFORNIA'S ELECTRICTY QUANDARY: (continued)

Summary of Important Conclusions

Controlled fusion processes, geothermal energy, and solar energy have been frequently proposed as future sources of electricity. These technologies are relatively new and largely undeveloped. It is expected that the time required for these new technologies to make a significant contribution to total demand will range from at least 20 years for geothermal energy to up to 50 years for fusion power. To have these energy sources available in quantity sooner would require both a massive infusion of federal funds to accelerate R&D and a strong commitment by industry to construct the necessary facilities. Neither appears likely at present.

Some of the environmental problems connected with continuing present growth trends have already been mentioned: risks of radioactive waste disposal, catastrophic accidents with nuclear reactors, and the land- and water-use problems connected with strip mining for coal in arid western regions. There are, of course, other environmental difficulties, including land-use conflicts in siting new electric generating facilities, air-pollution problems associated with fossil-fuel use, consumption of fresh water by power plants, and long-term climatological effects. Two of these - land-use conflicts and climatological effects-stand out as significant long-range problems. Although the latter problem is a potentially serious one, it is poorly understood at present. Further study is needed.

Land-use and water problems are closely interrelated. For example, if (as the utility companies would prefer) all new plants were to be placed on the coastline where ocean waters could be used cheaply for cooling, in the year 2000 there would be 1200-MW power plants every eight miles along the coast. By the year 2020 the same trends would lead to a power plant being located every two miles along the coast. But according to the findings of Ball, Salter, et al., there are only seventeen new power plant sites along the coastline that might be acceptable. Two hundred ninety-two sites were examined; two hundred seventy-five were eliminated from further consideration as a result of prohibitive physical features, excessive nearby population densities, predesignation as parklands, and seismic hazards. In addition, each of the seventeen possible sites involved a variety of other important land-use conflicts. The plants could be moved inland, if acceptable inland sites could be found, but this would almost certainly require construction of massive cooling towers which themselves would present aesthetic and climatological problems.

If, on the other hand, the growth rate of electricity demand could be reduced to 3 percent per year, only 23 new 1200-MW sites would be required between 1970 and 2000 instead of 127. If 6000 MW of capacity were located at each site, then only 5 sites would be needed to accommodate a 3-percent-per-year growth rate.

Estimates of capital requirements indicate that the state's electric utility sector will require an increasing share of the total investment dollars spent in California. Electric utility investment will increase to $5 billion to $7 billion in 2000 (at 1970 prices), which represents 8 to 12 percent of total projected investment. It is difficult to judge whether or not this growing share of the investment market will lead to serious problems. If one can take current pronouncements of various leaders of the electric utility industry as a guide, then the industry will have considerable difficulty in raising the large amounts of capital necessary for future expansion.

SUMMARY OF IMPORTANT CONCLUSIONS

Policies for slowing the growth of California's demand for electricity are both desirable and necessary. The projected growth of demand is so rapid that electricity consumption threatens to outstrip the state's ability to meet it while at the same time maintaining current and projected environmental quality standards.

If currently projected growth rates in national demands for energy resources continue, and if these demands are met exclusively from domestic supplies, then the nation's natural gas resources (as represented by the highest published estimates) could be exhausted between 1990 and 2000; petroleum could be exhausted between 1990 and 2010. Domestic fuel resources could be stretched by relying more heavily on imported fuels, accelerating the development and utilization of synthetic fuels derived from coal, developing new supply technologies that would not consume fossil fuels, and seeking to reduce the growth of the demand for energy.

In examining these options we find that safe, reliable technologies have not developed quickly enough. The severity of eventual fossil fuel scarcities has not been adequately recognized owing to unwarranted confidence in the promise of nuclear power, then fusion power and magnetohydrodynamics, and most recently solar power. These, of course, offer potential future solutions, but at present one cannot rely on their being available safely and in the quantities required in time to prevent the serious disruptions that are likely if electricity demand grows as rapidly as is predicted.

A commonly proposed solution is to proceed as fast as possible with the construction of nuclear power plants: first the light water nuclear reactor, then the breeder, and eventually the fusion reactor. This solution would vastly increase the number of nuclear reactors on the national landscape. According to national projections, there will be 900,000 MW or more of nuclear capacity installed by the year 2000 (as of June 1972, less than 12,000 MW of nuclear capacity were operating). California's electric utilities project 40,000 to 50,000 MW of nuclear capacity in the state by 1990; more than 90,000 MW of nuclear generating capacity could be operating in the state by the year 2000. (Currently there are only 493 MW of installed nuclear capacity in California.) The utilities' projections thus imply a hundredfold increase in nuclear capacity over the next 20 years and an increase of more than twice that in 30 years.

One can question whether such a headlong rush to nuclear power would be wise. The wisdom of such a move is particularly open to questions as long as the potentially serious safety and environmental problems connected with nuclear power reactors and their associated systems remain unsolved. These problems are (1) the risk of loss-of-coolant accidents and the questionable effectiveness of emergency core cooling systems in present reactor designs, and (2) the risk of accident during the transportation, processing, storage, or disposal of high-level radioactive wastes. Each problem has the potential for environmental disaster. One must therefore question the wisdom of including in the state's future power plans an expansion of nuclear power so rapid that more than 80 large nuclear reactors would have to be constructed in California over the next 30 years.

CALIFORNIA'S ELECTRICITY QUANDARY: (continued)

Summary of Important Conclusions

Because the electric utility industry is not labor-intensive, problems in meeting requirements for skilled operating personnel are not anticipated. But the situation with respect to power plant construction labor could be more serious. Serious quality control problems have been encountered with the large nuclear reactors now being completed; some of them appear to result from having to draw upon a pool of inadequately trained and motivated construction manpower. If quality control problems are to be solved, manpower training programs may be required.

The potential benefits of slowing electricity demand growth rates are significant. If it could be achieved, a 3-percent rate of growth would mean that California's power plant capacity would increase by only 27,000 MW (approximately 23 new 1200-MW power plants) between 1970 and 2000. This is a reduction of more than 100 power plants from the Conventional Utility Projection. It would, in fact, be possible to accommodate many of the new plants at sites currently planned for 1980. Moreover, problems connected with cooling towers, transmission lines, air pollution, and hazards from nuclear reactors would also be greatly diminished.

Slowed growth of demand, combined with new technological developments such as use of geothermal resources, could be extremely effective in resolving California's electricity quandary. If, for example, slowed growth in electricity demand were supplemented by rapid development of the geothermal resources of the Imperial Valley to their full 30,000-MW potential, then no new fossil-fueled or nuclear power plants would be needed in California after 1985.

Thorough exploration and intensive technological development efforts would be required to insure that after 1985, 2000 MW of geothermal capacity could be added each year, on average.

Although the benefits of slowed electricity growth rates can be easily seen, several important questions remain: How can growth be slowed? By how much can it be slowed? What unwanted side effects might result?

title: "The Potential Of Geothermal Energy"

future

concept: New energy technology may be developed in the future.

objective: Given the opportunity to read about geothermal energy, the student will be able to identify the possible future potential of geothermal energy.

time: 2 - 45 minute class periods

subject matter area: Science, Social Science, Language Arts

grade: 11-12

implementation:

Activity: 1. Have the students read the attached quotations concerning the future potential of geothermal energy.

2. Use the following questions and statements either as topics for discussion or as possible individual essay assignments for the students:

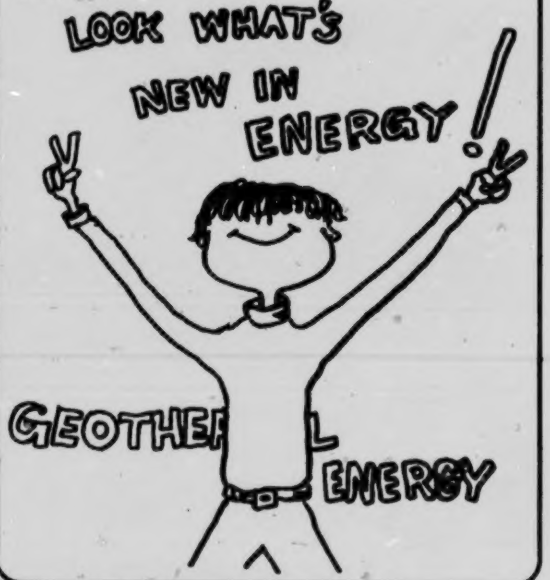
a. How is it possible that Dr. Fitz (Quotation #1) and Peck and Hickel's report (Quotation #2) might come up with such different figures for the future production of geothermal energy? Notice 1985 and 2000 predicted MW production.

b. Which of the two quotations, i.e., #1 and #2, would you most likely believe? What factors did you base your decision on?

c. Does Donald E. White of the U.S. Geological Survey in Quotation #3 agree more closely with the future predictions of Fitz (#1) or Hickel (#2)? Does his agreement influence your opinion on which quotation is probably most correct? Why?

materials:

Attached quotations #1, #2, #3 and #4 on "Future of Geothermal Energy."



activity no. 4

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implementation:

Activities:
(continued)

d. After reading these three quotations, would you classify geothermal energy as a renewable resource? Give evidence to back up your decision.

e. If you were to read any one of these quotations separately, would you feel it was reliable? How would you judge the reliability?

f. Now that you have compared these three quotations, what conclusions can you draw about the correctness and accuracy of "facts" you read? Can you give other examples of topics you have read about which also had conflicting information?

SUGGESTED CAREER EDUCATION ACTIVITY:

Given the opportunity to view a commercial film on geothermal energy - and discuss the potential for new occupations which are indicated by the potential future development of geothermal energy, the student will be able to discuss the economic aspects of the costs of geothermal energy to the consumer.

materials:

Provide the students with Quotation #4 and have them compare it with the three they have already read. This will evaluate the student's understanding of the forecast for geothermal energy's future role in relation to our total energy needs. It will also help to reinforce the idea that everything one reads should be carefully considered and evaluated for its credibility.

Two possible questions which could be asked about Quotation #4 are:

- Using the criteria for credibility which you established when reading the other three quotations, determine whether or not you feel this quotation from Seattle City Light is a credible source. Explain your reasoning.
- Does this quotation tend to agree with Fitz (#1) and White's (#3) general predictions for the future potential of geothermal energy? Give evidence to support your opinion.

Developed by: Lynn Nixon
Everett School District
Everett, WA

QUOTATIONS
ON
FUTURE OF GEOTHERMAL ENERGY

QUOTATION #1

"The 1972-73 capacity figures are based on plants already on order, while the capacity between 1975 and 1985 is based on the known reserves of geothermal energy. It was assumed that a power plant would last for thirty years, hence division of the known reserves by 30 gave the energy available for power. This, in turn, was divided by the heat rate (in Btu's/kwh) to give the capacity that could be supported by known reserves. This resulted in an adjusted figure of approximately 4,000 megawatts. The 1985-2000 capacity figures result from an arbitrary assignment of approximately fifteen per cent of extra capacity to geothermal.

The resulting estimate of geothermal electric power is as follows:

1971	192
1975	660
1980	2,000
1985	4,000
2000	40,000

Assuming a load factor of 80 per cent for geothermal power, geothermal generation would produce .1% in 1980, .2% in 1985 and 1.5% by 2000 of the overall United States energy consumption."[1]

---

[1] "Three Major Types of Geothermal Systems - Brine, Hot Dry Rock, "Hot Spot," Aware by Dr. Thomas O. Fitz, Deputy Geothermal Coordinator, United States Department of the Interior.

QUOTATION #2

"The quantity of heat (geothermal energy) stored within the Earth is enormous. Taking all the world's energy needs from the Earth for a million years would decrease the temperature only a fraction of one degree.

Geothermal energy resources have been recently assessed by the Department of Interior[1] for the Federal Council of Science and Technology and the NSF/RANN sponsored workshop held by the University of Alaska.[2] Both studies suggested that a well supported research and development program could result in 132,000 MW of geothermal based electrical generating capacity by 1985 and 395,000 MW by the year 2000. This represents 16 per cent and 25 per cent of the anticipated total generating capacity in the respective years."

(1) (Peck Report) "Assessment of Geothermal Energy Resources." Dallas P. Peck, Coordinator, Department of Interior, September 25, 1972.

(2) (Hickel Report) "Geothermal Energy" - Final Report of Geothermal Resources Research Conference, Seattle, Washington. September 18-20, 1972, Chairman: Walter Hickel. University of Alaska NSF/RANN.

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[1] Proceedings - Energy Facts for Concerned Citizens - A National Forum - Sponsored by University of Idaho and W.S.U. - Supported by the National Science Foundation G.M. - 36455, Page 141.

[2] "Geothermal Energy," Frank E. Rom (with George Kaplan), National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

QUOTATION #3

"For most of the better known geothermal areas of the world, White has estimated the rate at which heat is discharged to the surface of the earth, and has also estimated the amount of stored heat above surface temperatures to depths of three kilometers and ten kilometers. From the areas studied, he estimates that the world's total natural heat flow from all hydrothermal areas is of the order of 3×10^{10} cal/sec or about 1.3×10^{11} thermal watts. He also estimates that the total stored heat of all hydrothermal systems to a depth of 3 kilometers amounts to 2×10^{21} cal (8×10^{21} thermal joules). Of the world's hydrothermal energy, White estimates that about 5-10 per cent occurs in the United States, mainly in the western states.

To obtain an order of magnitude for geothermal power, White assumes that about 1 per cent of the hydrothermal energy can be converted into electrical energy. For the depth of 10 kilometers, 1 per cent of the estimated thermal energy would be 1×10^{20} cal or 4×10^{20} thermal joules of electrical energy, or about 3×10^{6} MW-yrs. Then, if this amount of energy were to be withdrawn during a period of 50 years, the average annual geothermal electrical power would be

$$\frac{3 \times 10^{6} \text{ MW-yrs}}{50 \text{ yrs}} = 60{,}000 \text{ MW}$$

or about 60 times the present installed capacity. This agrees with White's conclusion that the world's geothermal energy resources could sustain a rate of withdrawal of 10-100 times that of the present for at least the next 50 years.

QUOTATION #3 (Continued)

It thus appears that the ultimate magnitude of geothermal power production will probably be in the tens of thousands of megawatts. While this is a significant amount of power, a better idea of just how significant can be obtained by comparison with other sources of power. A figure of 60,000 MW for geothermal power is about the same as that of 64,000 MW given for the world's potential tidal power, but only 2 per cent of the 2.8 x 10^6 MW given for the world's potential water power from conventional sources. It is only about a third larger than the present hydroelectric power capacity, or only about 20 per cent of the present total installed electric power capacity of the United States. Hence, while geothermal energy is capable of sustaining a large number of small power plants in a limited number of localities, it still represents only a small fraction of the world's total energy requirements, and this for only a limited period of time."

Resources and Man, National Academy of Sciences, W.H. Freeman and Company, San Francisco, 1969, Pages 217-218.

QUOTATION #4

"The actual production characteristics of geothermal areas are uncertain. While the heat resource has been loosely referred to as renewable and unlimited, the experience at Wairakei, New Zealand, indicates that steam pressure in that field diminished from over 700 pounds per square inch in 1975 to less than 500 pounds per square inch ten years later. While in the span of geologic time the earth's heat may seem a virtually unlimited resource, it is likely that many geo-heat wells will become prematurely unproductive much as water and oil wells do, unless means are devised for renewing ground water by some means that will not produce undesirable local side effects.

Only the most courageous and optimistic utility management can enthusiastically embrace geothermal power as a viable and environmentally acceptable method of generating electricity at this time."

Power Generation Alternatives, Seattle City Light, Second Edition, 1972, Pages 17 and 75.

title: "Solar Energy Collection and Production"

future ?

concept: New energy technology may be developed in the future.

objective: Given the opportunity to study a packet on solar energy, the student will be able to demonstrate his knowledge of the workings and components of solar collection and production.

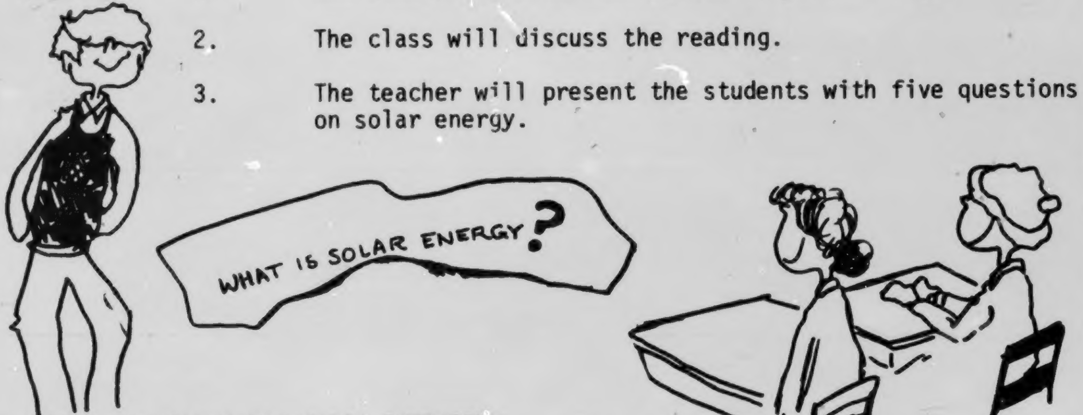
time: 1 - 45 minute class period

subject matter area: All

grade: 10-12

implementation:

Activity:
1. The students are to read packet on solar energy.
2. The class will discuss the reading.
3. The teacher will present the students with five questions on solar energy.


WHAT IS SOLAR ENERGY?

SUGGESTED CAREER EDUCATION ACTIVITY:

Given the opportunity to participate in a class discussion, the student will be able to discuss the implications of solar energy costs to the wage earner.

materials:

Enclosed packet on solar energy.

SUGGESTED ASSESSMENT ACTIVITY:

Given the opportunity to participate in a class discussion, the student will be able to answer five questions on solar energy.

Developed by: Tom Schultz
Everett School District
Everett, WA

Revised by: Duane K. Altig

activity no. 5

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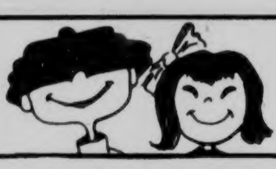

SOLAR ENERGY

The energy that comes from the sun is called solar energy. Enough energy falls on the Sahara Desert that if one percent were collected it would supply the world's electrical needs for the year 2,000. Today's energy supply for the United States could be collected on 21% of Arizona's land mass if solar plants as efficient as a standard fossil fuel electrical plant can be built. Solar energy is non-polluting, renewable and very abundant but, unfortunately, very expensive to collect.

Solar energy has been used to power 90% of our unmanned space vehicles through the use of solar cells. A solar cell is a device that changes the sun's energy directly into electridity. A solar cell contains no moving parts, has a high reliability and low maintenance. These solar cells could be put on roof tops of houses to collect electricity for the home or over the sands of deserts to collect electrical power for industry and homes when sunshine is not prevalent. Solar energy could also be stored in the summer in the form of hydrogen gas to be used in the winter when solar power is not abundant. Satellites orbiting the Earth could also collect energy from the sun and beam it back to the Earth in the form of microwaves. Microwaves, however, are a source of radiation and if this energy were misdirected to the earth by a satellite being off course, it could have an uncertain effect on the population and environment belo[illegible]

Solar cells that we have today have an efficiency of 10 to 15% and cost about $4 per square inch. Making a solar plant today with these prices would raise the cost of electricity 100 times. If your bill today was $38, then using solar power it would jump to $3,800. This factor alone is why we use cheap coal, oil, hydro or nuclear power.

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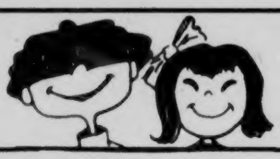

SOLAR ENERGY

continued

The most attractive method of capturing the sun's energy is through a solar thermal generation plant.

Giant solar collectors would gather the energy from the sun. This energy would then be transported to a liquid coolant. The hot coolant would exchange its energy in a heat exchanger to another substance which would in turn spin the blades of a turbine to generate electricity. The coolants are then condensed, cooled and recycled. Electricity generated in this fashion would cost 1.5 to 8 times what you are now paying. Thus, if you now pay $40, your bill could be as low as $60 or as high as $320. Since thermal generation plants have not been constructed yet we do not know for sure how much their electricity will cost. The above figures range over all the cost estimates that are currently available.

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Solar Energy Questions

1. What is solar energy?
2. Why is solar energy not used to a great extent today?
3. Which type of solar energy collection do you think would be most feasible?
4. Is solar collection and transmission in space safe?
5. Give an example of a current use of solar energy.

Solar Energy Answers

1. Energy that comes from the sun is solar energy.
2. Solar energy is very expensive and is not widely used.
3. Solar thermal is many times cheaper than any other type of solar energy.
4. Transmission from space would be in the form of microwaves, which would have an unknown effect on the population and the environment of the earth.
5. Solar energy is used in 90% of unmanned space craft.

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title: "Nuclear Plant Locations"

future ?

concept: Future energy technologies will be judged by their combined economic, social, political, technical and environmental impacts.

objective: Given the opportunity to gather the necessary information, the student will be able to demonstrate an understanding of nuclear plant locations and the need to increase the number of reactors.

time: 1 - 45 minute class period

subject matter area: All

grade: 10-12

activity no. 6

implementation:

Activity:

1. Distribute copies of maps to each student.

2. Discuss maps with the class relative to symbols used and the relationships of the two maps.

3. The following questions may be used as discussion questions or as individual essay questions: ?

   a. Where are most of the existing and proposed nuclear plants located?
      - Which area of the United States?
      - Which state (s) has (have) the most?

   b. How many nuclear plants are already in existence and being operated as of 1978?

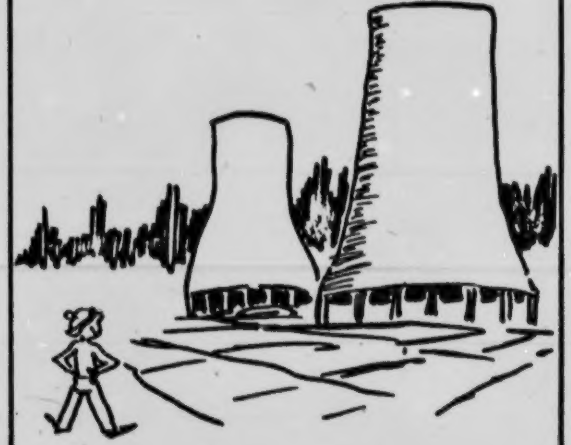
   c. What percentage of the total number of existing and prospective plants is this?

   d. What percentage of the total are plants which are being built?

materials:

Attached maps:

Location of nuclear plants.
Location of uranium sources.
Answers to questions (attached).



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implementation:

Activities: (continued)

e. What percentage of the total are reactors in the planning stage?

f. What conclusions can you draw as far as the future trends of nuclear energy, using the percentages you figured out in "c," "d," and "e."

g. What reasons can you think of to explain why most of the nuclear plants are or will be located along the East Coast?

h. Look at the map showing the location of uranium sources. How does their location compare to the location of the nuclear plants?

i. Can you give any reasons why the location of the uranium is not the location of nuclear plants?

j. What percentage of the 1977 total electric utility capacity does the total number of nuclear kilowatts represent? How does this answer relate to your answer to "f."

Optional Activity: The students may also be given a quiz as follows:

1. Most nuclear plants are located:
   - In the Middle West.
   - In the South West.
   - On the East Coast.
   - On the West Coast.
2. Which of the following states has more nuclear plants than the other ones listed?
   - Alabama.
   - Illinois.
   - Utah.
   - Washington.

materials:

MOST NUCLEAR PLANTS ARE LOCATED ON THE WEST COAST ? !
REACTORS WILL INCREASE OR DECREASE IN YEARS TO COME

implementation:

Activities:
(continued)

3. The percentage of reactors which will be put into use in the coming years will:
   - Decrease.
   - Increase.
   - Stay the same.

4. Most uranium mines are found in:
   - Arkansas.
   - New York.
   - Pennsylvania.
   - Wyoming.

5. The operable number of nuclear kilowatts represents which percentage of the 1977 total electrical utility capacity?
   - About 9%
   - About 20%
   - About 42%
   - About 59%

SUGGESTED CAREER EDUCATION ACTIVITY:

Given the opportunity to complete the necessary research, the student will be able to discuss the employment opportunities offered by new nuclear plant construction, i.e. types of jobs, pay scales, skilled jobs, semi- or unskilled jobs, etc.

materials:

Activity 1: Evaluation can be made by correcting the questions using the answer key which is included.

Activity 2: This quiz is optional.

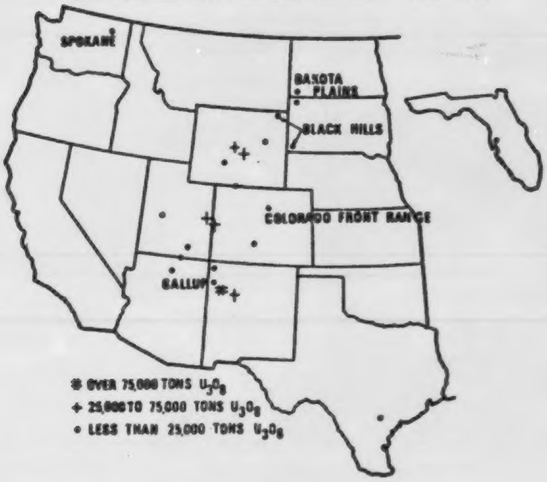
SUGGESTED ASSESSMENT PROCEDURE:

Given the background knowledge, the student will be able to answer a number of questions related to nuclear plant location.

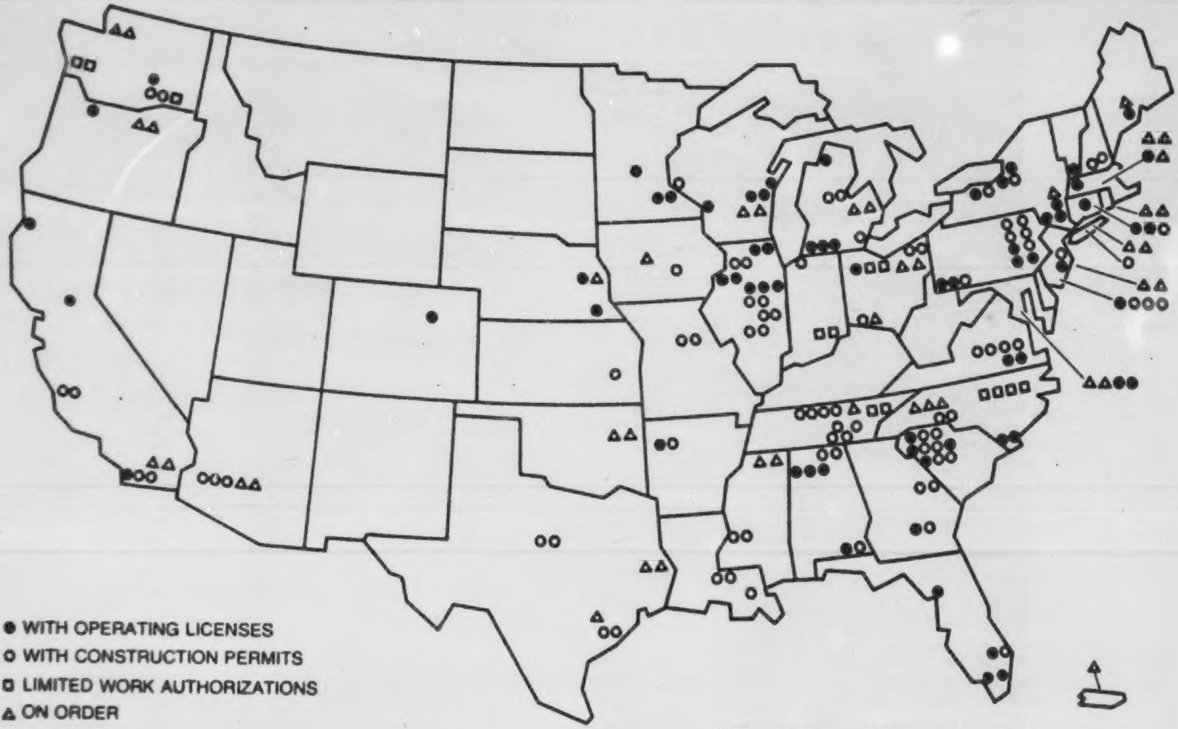
Developed by: Lynn Nixon
Seattle, WA

Revised by: Duane K. Altig

URANIUM DEPOSITS IN THE UNITED STATES 1965


SPOKANE
DAKOTA PLAINS
BLACK HILLS
COLORADO FRONT RANGE
GALLUP
* OVER 75,000 TONS U_3O_8
+ 25,000 TO 75,000 TONS U_3O_8
• LESS THAN 25,000 TONS U_3O_8

NUCLEAR PLANTS OPERABLE, UNDER CONSTRUCTION, OR PROPOSED AT THE BEGINNING OF 1978


● WITH OPERATING LICENSES
○ WITH CONSTRUCTION PERMITS
▫ LIMITED WORK AUTHORIZATIONS
△ ON ORDER

Operable Nuclear Plant Capacity As Of December, 1977: 49,882,000 kilowatts (approx)
Total Electrical Utility Capacity As Of December, 1977: 557,119,000 kilowatts (approx)

Possible Answers To Questions on Nuclear Plant Locations

1. a) Most of the existing and proposed nuclear plants are located in the eastern part of the United States.

   b) The states which have the most existing and proposed plants are:
   New York and Illinois (14 each)

2. 36 operating in 1973

3. $\frac{36}{172} = \frac{X}{100}$ ____________ 20.9%

4. $\frac{56}{172} = \frac{X}{100}$ ____________ 32.6%

5. $\frac{80}{172} = \frac{X}{100}$ ____________ 46.5%

6. The percentages are increasing as one looks to the future so it could be concluded that nuclear reactors will provide more and more of our energy requirements.

7. West Coast and mountainous regions have hydro power and can use this to produce electricity, whereas the East Coast does not have this advantage. Also, the East Coast has a higher population density and requires more energy than most other parts of the United States.

8. Uranium is mined in states which have only one nuclear power plant between all of them and not in the states which have the majority of nuclear plants.

9. Areas which have uranium are mountainous and so these areas have hydro power and low density of people: therefore, the need for nuclear power is small if at all.

10. $\frac{169{,}202{,}400}{399{,}606{,}000} = \frac{X}{100}$ or rounded off $\frac{169}{400} = \frac{X}{100}$

$$400X = 16{,}900$$
$$X = \text{about } 42\%$$

More evidence that nuclear energy is a growing and important source of future energy.

Answers to Quiz on Nuclear Plant Locations

1. East Coast
2. Illinois
3. Increase
4. Wyoming
5. About 9%

title: "Nuclear Fusion Vocabulary"

future ?

concept: Future energy technologies will be judged by their combined economic, social, political, technical and environmental impacts.

objective: Given the opportunity to obtain information on nuclear fusion, the student will be able to demonstrate a knowledge of fusion reactions and the necessary vocabulary to use these concepts.

time: 1-2 45 minute class periods

subject matter area: Science

grade: 11-12

implementation:

Activity: 1. Either have the students read the attached material on nuclear fusion or the teacher could lecture on this material.

2. Distribute the crossword puzzle which deals with concepts and ideas presented in the reading material. Students are to complete the puzzle.

SUGGESTED CAREER EDUCATION ACTIVITY:

Given the opportunity to gather the necessary background information, the student will be able to describe in writing, how the present day attitudes about nuclear power plants might influence the development of nuclear power sources and, how these social pressures might effect future jobs and working conditions.

materials:

Attached reading materials.
Crossword puzzle.

Grade the crossword puzzle using the key provided.

SUGGESTED ASSESSMENT ACTIVITY:

Given the opportunity to do the necessary background reading, the student will be able to complete a crossword puzzle of nuclear fusion vocabulary words.

Developed by: Lynn Nixon
Everett School District
Everett, WA

activity no. 7

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NUCLEAR FUSION

Fusion is a type of energy production which utilizes the energy in an atom. The actual definition of fusion is "a process which occurs when light atoms like hydrogen are heated to a high enough temperature to fuse together and form new heavier atoms." Heat is released in this process. Unfortunately, scientists are still trying to attain the point where the fusion process gives off more energy than it receives. Present methods use more energy input than is received as output.

Approximately ten years* are estimated to be necessary before the system will be producing sufficient quantities of energy. To produce this energy it would be necessary to raise the temperature of the atoms to one hundred million degrees Kelvin and to hold that temperature for 0.1-1.0 second. Some problems arise at this temperature. All materials become electrically charged gases called plasmas. Any normal container to hold the atoms would also turn into an electrically charged gas. This means that finding a method to contain the necessary atoms is posing a difficulty.

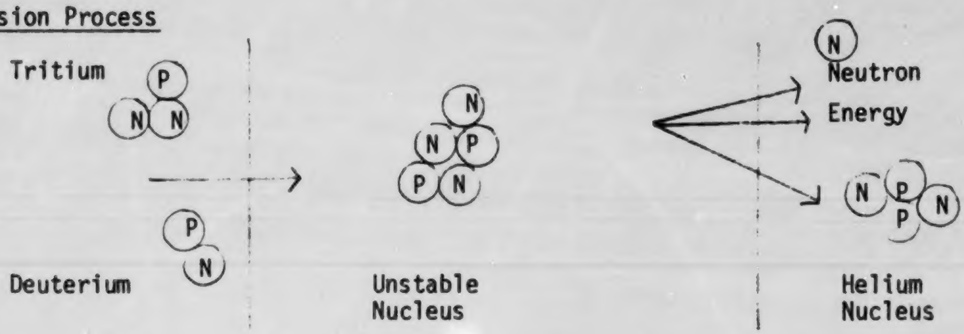
Possible methods of containing the electrically charged gas include magnetic bottles. Because the plasma has an electrical charge it can be confined by a magnetic field. This would be like putting all the positive poles of bar magnets inward and having the positive particles inside. They would repel each other and so the particles will be crowded together in the center. There are two types of magnetic bottle shapes. The open or linear type has a magnetic field which resembles the seams on a baseball. This shape has a problem in that some leakage can occur at the ends of the tube. The other type, toroidal, is shaped somewhat like a doughnut and confines the plasma to the center away from the walls and allows minimal leakage.

---

*Ed. Note: This is a minimum time estimate. Many experts would increase it several fold.

The fusion reaction releases around 80% of its energy in the form of high energy neutrons. These are absorbed into a liquid lithium shield which causes heat to be created. This heated lithium is then pumped to a heat exchanger where steam is produced to drive a conventional turbine generator. Radioactive tritium, which is generated within the shield, is continually recycled back into the plasma and is used as fuel.

Fusion Process

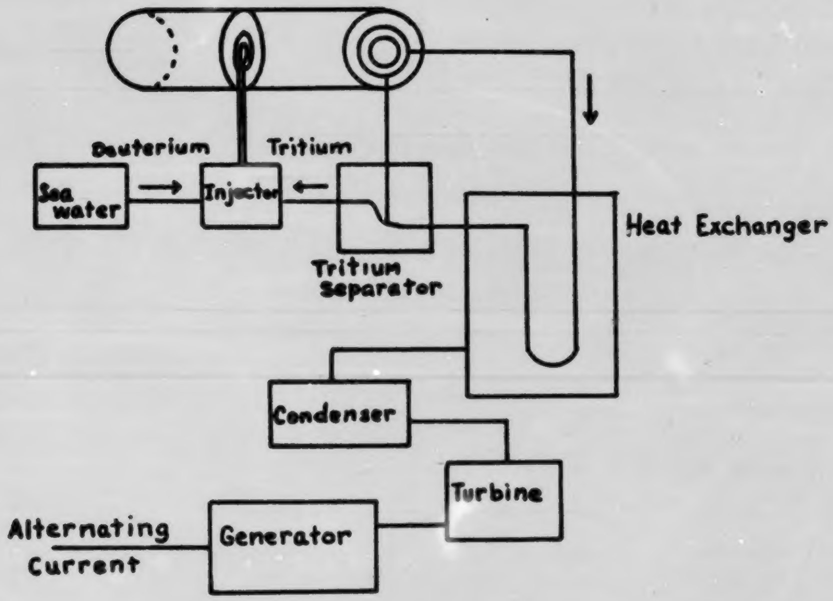


(P) = proton in nucleus of atom

(N) = neutron in nucleus of atom

Tritium and deuterium are both forms of a hydrogen atom.

Figure 1



Fusion Reactor

Figure 2

Several means of raising these atoms to sufficient temperature have been suggested. Electric current is capable of raising the temperature to one million degrees Kelvin. Then a rapid increase in the force of the magnetic field will result in a fast decrease in volume and an increase in temperature. Laser beams are also being tested as a possible means of creating a sufficiently high temperature.

The apparent energy capabilities of the fusion reaction are very favorable. The energy that could be released from the heavy water (deuterium and tritium) in one gallon of seawater is equal to the heat which can be produced by burning 300 gallons of gasoline.(3) It has also been calculated that the energy available from the fusion of deuterium in all the seawater is one thousand times greater than all the combustion energy available in all of the remaining coal reserves.(4) Samuel Glasstone in his article "Controlled Nuclear Fusion" also figured out the possible quantity of energy available from fusion. In complete fusion of the deuterons in one gram of deuterium about $5.6\text{x}10^{10}$ calories would be produced. In one gallon of seawater there is about 1/8 gram deuterium which would yield $7\text{x}10^{9}$ calories or the equivalent of 300 gallons of gasoline. The total amount of deuterium in the ocean is about $4.5\text{x}10^{19}$ grams, and so he figures fusion energy equals $2.5\text{x}10^{30}$ calories or $3\text{x}10^{20}$ kilowatt years. Since the world is now using $5\text{x}10^{9}$ kilowatt per year, this source (fusion energy) should last billions of years.(5)

The potential advantages of fusion as a source of energy are several. It appears to have an inexhaustible supply of fuel. Even though radioactive tritium is formed, there is a smaller amount of radioactive waste per unit of power generated than in fission reactors. Should it prove possible to generate electricity directly from the plasma, then there would be a decrease in heat released to the surrounding environment and this would result in a higher energy efficiency--somewhere between 60 - 90% (as compared with about 30% efficiency in a nuclear fission reactor). The fusion reaction produces a surplus of fast neutrons which is ten times greater than a fission reactor which is at the same power level. Therefore, a fusion reactor could convert U238 into plutonium ten times faster than a breeder reactor.

Since a fusion reactor could not get out of control and produce too large an amount of radioactive material, there is less need for so very many safety precautions necessary for fission and breeder reactions. No hypothetical case has been foreseen in which the plasma could cause "hot" spots, melt down or explode. The fusion reaction appears to be fail-safe. If the magnetic field should fail, then the plasma would spread out and quench itself against the walls of its containing vessel. A typical fusion plant would not need stacks or a reactor containment building. Two of the most difficult problems are control of the plasma leakage from the fusion containment vessel and the recovery and disposal of radioactive tritium waste products. (6)

Further research is also being done on different types of fusion reactions. A group at Rutgers University is studying a system called the "migma cell." Using a magnetic field the ions are forced to assume a precise speed and a figure eight orbit. This creates a situation in which a large number of ions collide at the mid-point of the figure eight. This migma-cell configuration is equal in energy output to a plasma of 2 billion degrees Kelvin. Experimental work has shown that figure eights can be achieved, but a uniform configuration with multiple orbits has not yet been achieved.(7)

Laser-induced fusion is also being tried. A light beam from an infrared laser is split into six beams which simultaneously strike a pellet of deuterium and tritium one millimeter in diameter. This laser light compresses the spherical pellet to 1/25 of its original size, which increases its density to 100 times that of lead. The result of this is a temperature rise in the pellet of 100 billion degrees centigrade or 100 times the fusion temperature of the sun. The energy produced by each pellet would be about 25,000 calories or enough energy to light a 100 watt light bulb for 290 hours. Unfortunately, the procedure may be decades away. New lasers with ten thousand times the increase in energy, more pulses per second and efficiencies one hundred times higher than those of existing ones are necessary to achieve these results.(8) While scientists may still be waiting for a laser with exactly the correct power qualifications, KMS Industries just recently carried out a successful reduction in pellet size and believe that fusion using the laser may be as close as 1980.(9)

One other possibility is using an electron beam rather than a "magnetic bottle." The electrons would be fired in short pulses and the nuclear fuel would be fed into the beam with each pulse. Focusing the beam to get the energy density necessary to achieve a fusion temperature of about 100 million degrees Kelvin has not yet been achieved. Another problem is being able to shorten the pulses, because only a fraction of a second is required to ignite the fusion reaction and long pulses waste input energy.(10)

Much research is being carried out on fusion reactions, but all present knowledge indicates that their practical use, if ever, is still many years in the future.

Bibliography

[1] Power Generation Alternatives, City of Seattle, Department of Lighting, 1972, p.27.

[2] Ibid., p.55.

[3] Ibid., p.27.

[4] Ibid., p.27.

[5] Glasstone, Samuel, "Controlled Nuclear Fusion," A World of the Atom Series Booklet, U.S. Atomic Energy Commission Office of Information Services, 1964.

[6] Power Generation Alternatives, City of Seattle, Department of Lighting, 1972, p.54.

[7] Science News, Vol. 103, June 16, 1973, p.39.

[8] "Laser-Induced Fusion," Saturday Review, Vol. 1, No. 4, May, 1973, p.57.

[9] Science News, Vol. 105, No. 7, February 16, 1974, p.101.

[10] "Fusion By Electron Beam,"Scientific American, July, 1973, p.48.

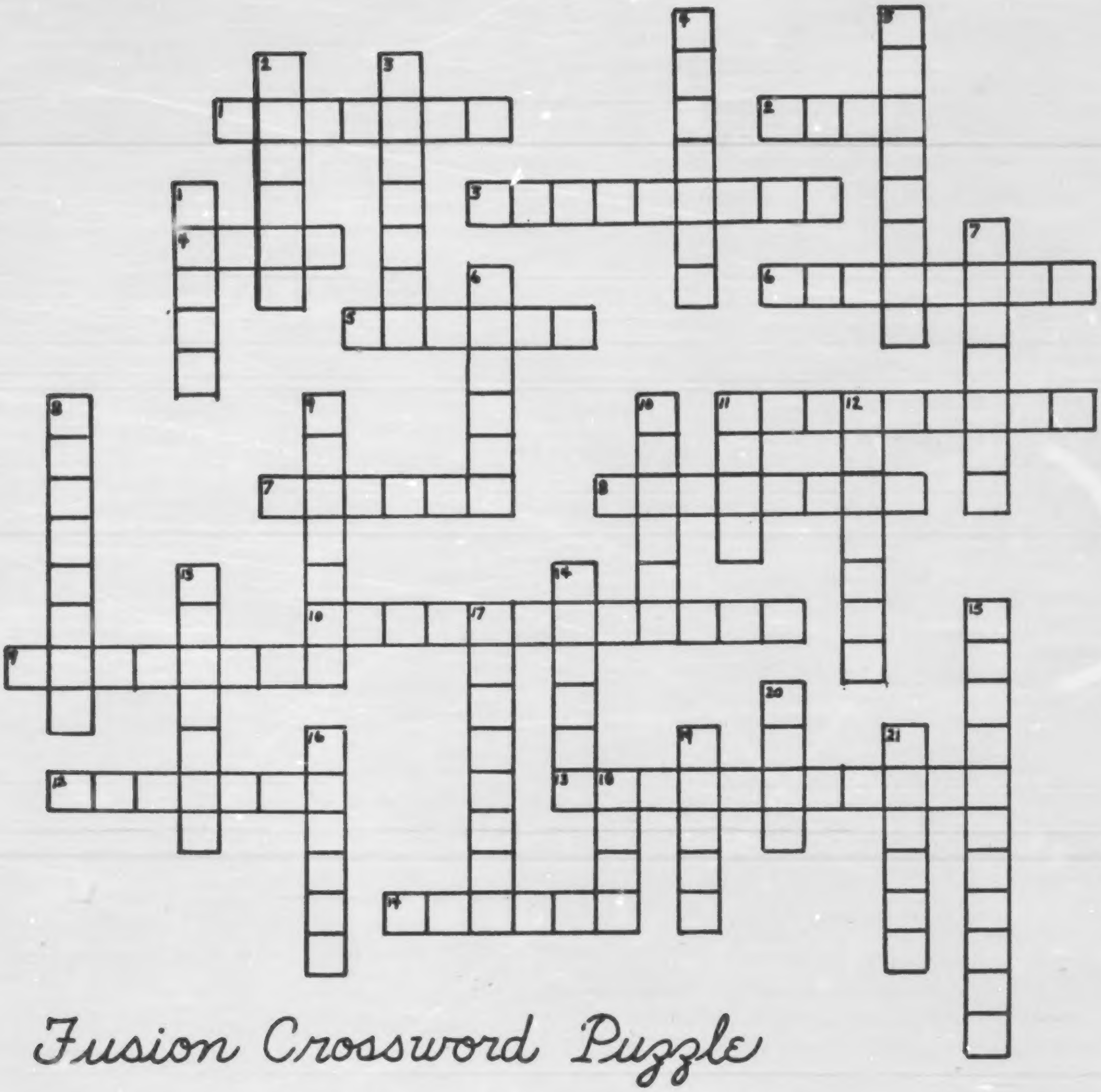
FUSION CROSSWORD PUZZLE

ACROSS

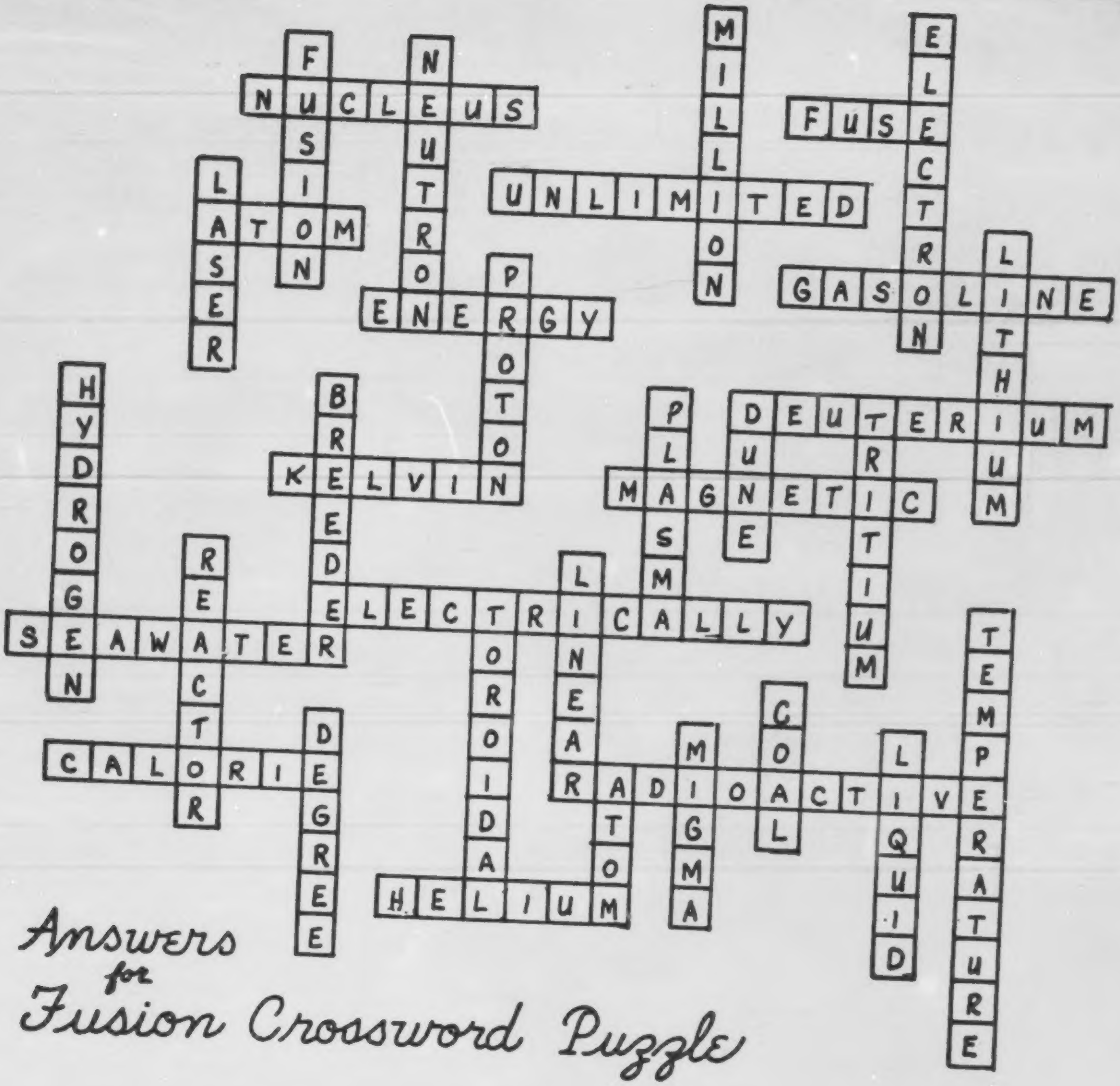
1. The central part of an atom
2. This is what the nuclei of atoms do during fusion
3. Some scientists believe our energy supply will be this way if we can perfect the fusion reaction
4. Smallest particle of any element which can still be identified as that element
5. Ability to do work
6. One gallon of seawater can produce the equivalent energy of 300 gallons of ________
7. A measure of temperature like Celsius and Fahrenheit
8. A ________ field is one way to contain the charged gases during fusion
9. This is a source of deuterium
10. Atoms heated to a very high temperature form an ________ charged gas
11. A hydrogen atom with one proton and one neutron is called ________
12. One means of measuring energy
13. During the fusion reaction, tritium becomes ________
14. This element is a product of the fusion reaction.

DOWN

1. This type of beam is one way to raise fusion reaction to high temperatures
2. Type of reaction where two nuclei fuse and give off energy
3. The uncharged particle in the nucleus of an atom
4. The temperature necessary for fusion is about one _____ degrees Kelvin
5. This negatively charged part of the atom could be fired in a beam at the fuel for fusion
6. The positively charged particle in an atomic nucleus
7. This element in a liquid form creates a shield around the reaction
8. The lightest and smallest atom (element)
9. The fusion reaction can convert U238 to plutonium ten times faster than this kind of reactor
10. Electrically charged gas
11. Oil is sometimes found in areas with these sand ________
12. This is the heaviest form of hydrogen with one proton and two neutrons
13. This puzzle is concerned with one type of nuclear ________
14. Type of magnetic bottle which sometimes has leakage at the ends
15. Fusion must take place at an extremely high ________
16. Way of measuring temperature
17. Doughnut-shaped magnetic bottle for containing fusion particle
18. Same as 4 across
19. Special research is being done on a _____ cell which causes particles to collide in a figure 8 pattern
20. The energy available from fusion could be one thousand times greater than all energy available from all the remaining ___________ deposits.
21. Lithium is in this state when it is forming a shield for the fusion reaction



Fusion Crossword Puzzle



Answers
for
Fusion Crossword Puzzle

title: "Trade-Offs in Population Growth and Energy Use"

future ?

concept: Energy availability will affect future life styles and cultural conditions.

objective: Given the opportunity to complete a variety of related tasks, the student will be able to correlate probable growth rates in population with growth rates in energy use, and hypothesize about some probable trade-offs that may become necessary.

time: 4 - 45 minute class periods

subject matter area: Mathematics, Science Social Science

grade: 10-12

implementation:

Activity: 1. To become aware of future requirements for energy and its dependence on numbers of people, their needs, and the resulting economic activity, the student constructs three graphs:

   a. A line graph showing U.S. population growth from 1940 to 1973 and projected growth through the year 1985.
   b. A bar graph to demonstrate population growth by age groups over the same periods as (a) above.
   c. A bar graph of per capita use of energy in 1955, 1970 and projected use for 1985.

2. Directions:

   a. Each graph is constructed on a separate sheet of paper (for convenience use ¼ inch graph paper).
   b. Graphs should be appropriately titled (e.g., Per Capita Energy Use, Past, Present, and Future).
   c. Vertical and horizontal units should be chosen so as to get a graph that utilizes most of the space available (see appended graphs for sample units).
   d. Graphs should be labeled and colored for maximum clarity and readability.

materials:

¼ inch graph paper
colored pencils
straight edge

activity no. 8

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implementation:

Activities: (continued)

e. Each graph should state the source: "Outlook for Energy in the United States to 1985", The Chase Manhattan Bank, 1972.

f. Space could be set aside at the bottom of the graph for the student's interpretation of the graph, hypotheses based on the data, conclusions drawn from them, and correlations among the three graphs.

3. Data For the Graphs

Graph on U. S. Resident Population:

Year	Population in Millions of People
1940	130
1945	145
1950	150
1955	163
1960	175
1965	190
1970	203
1975	210
1980	225
1985	241

Graph on Population Growth by Age Group:

a. In the period from 1940-1955, the population grew by 33 million. Of this growth, about one million were in the 20-35 year-old age group.

b. In the period from 1955-1970, the population grew by 40 million. Of this growth, about 8 million were in the 20-35 year-old age group.

c. In the period from 1970-1985, projected growth (based on Bureau of Census statistics) is about 37 million. Of this growth, about 19 million will be in the 20-35 year-old age group.

materials:

1. The student will recall the approximate rate of growth for the 15-year periods from 1940 to 1985. (33 million, 40 million, and 37 million are the actual figures. The average is about 36 million. Accept answers in the range 33 to 40 million).

2. The student will in a 15 minute essay answer discuss the significance of the rapid rate of growth in the 20-35 age group. Answers should include:
   a. This is the "marriage" group.
   b. Most children are born to parents in this group.
   c. Most major lifetime purchases are made during this time.
   d. Economic patterns are directly related to energy use patterns.

implementation:

Activities:
(continued)

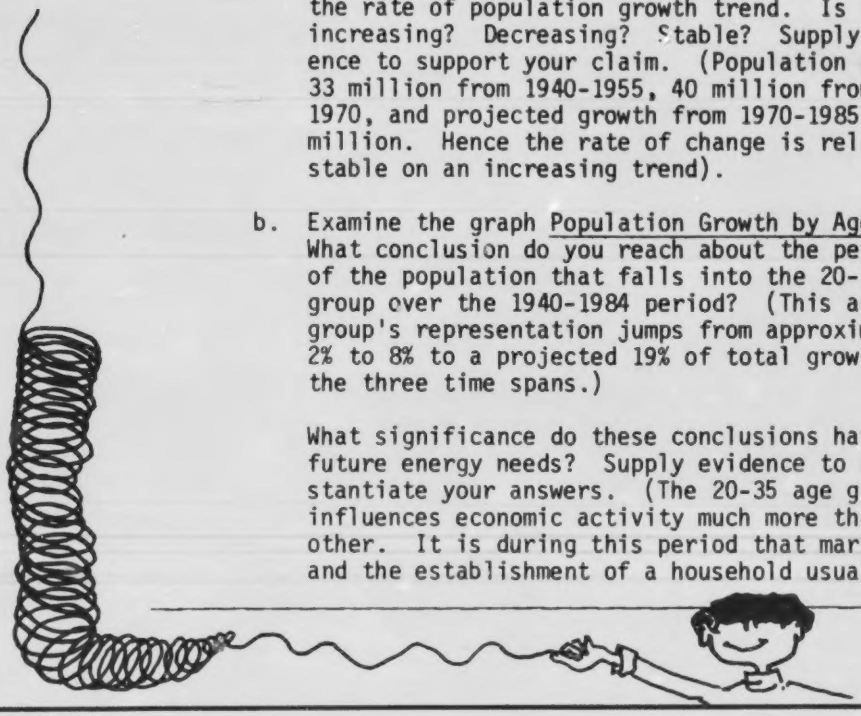
Graph on Per Capita Use of Energy (units are barrels yearly-oil equivalent).
a. 1955: 43 barrels
b. 1970: 60 barrels
c. 1985: 95 barrels

4. Interpretation: With these graphs as data sources, the student analyzes, compares, contrasts, and hypothesizes about relationships between population growth and energy-need growth.

   a. By comparing population growth figures over three fifteen-year periods, make a statement about the rate of population growth trend. Is it increasing? Decreasing? Stable? Supply evidence to support your claim. (Population grew 33 million from 1940-1955, 40 million from 1955-1970, and projected growth from 1970-1985 is 37 million. Hence the rate of change is relatively stable on an increasing trend).

   b. Examine the graph Population Growth by Age Group. What conclusion do you reach about the percentage of the population that falls into the 20-35 age group over the 1940-1984 period? (This age group's representation jumps from approximately 2% to 8% to a projected 19% of total growth over the three time spans.)

   What significance do these conclusions have for future energy needs? Supply evidence to substantiate your answers. (The 20-35 age group influences economic activity much more than any other. It is during this period that marriage and the establishment of a household usually occur.



materials:

1. Each student will be asked to prepare probable statements outlining priorities and possible trade-offs that these data (in the graphs) seem to dictate or suggest. These statements will be from the following viewpoints:

   a. A retired person on a small, fixed income.
   b. A citizen in an underdeveloped area with rising expectations.
   c. An industrialist.
   d. A member of the middle class 20-35 age group.
   e. An unborn child, a citizen of the near future.

implementation:

Activities:
(continued)

Most parents of children born fall within this group. Equipping new and expanding households requires purchase of a wide range of products. During this period the need for goods and services is greatest. Clearly, the the economic activity required to satisfy these needs must increase at a rapid rate. And, as a result, the needs for energy will expand rapidly too.)

C. Examine the Per Capita Use of Energy Graph. The use of energy has doubled in the last 30 years. It appears likely that it will more than double in the next 30 years. Why does the use of energy growth rate outstrip the population growth? (As the standard of living rises, so does the rate of energy use. Underdeveloped regions have greater and greater demands as they struggle to develop.) Comparing population growth figures with per capita use of energy figures, what conclusions can you reach about energy needs in the future? (If these figures are confirmed, the energy supply pool must be increased at a much greater rate than the population growth rate. The only alternative seems to be a change in life style to a less energy-intensive society).

5. Samples of the required graphs (see attached).

materials:

implementation:

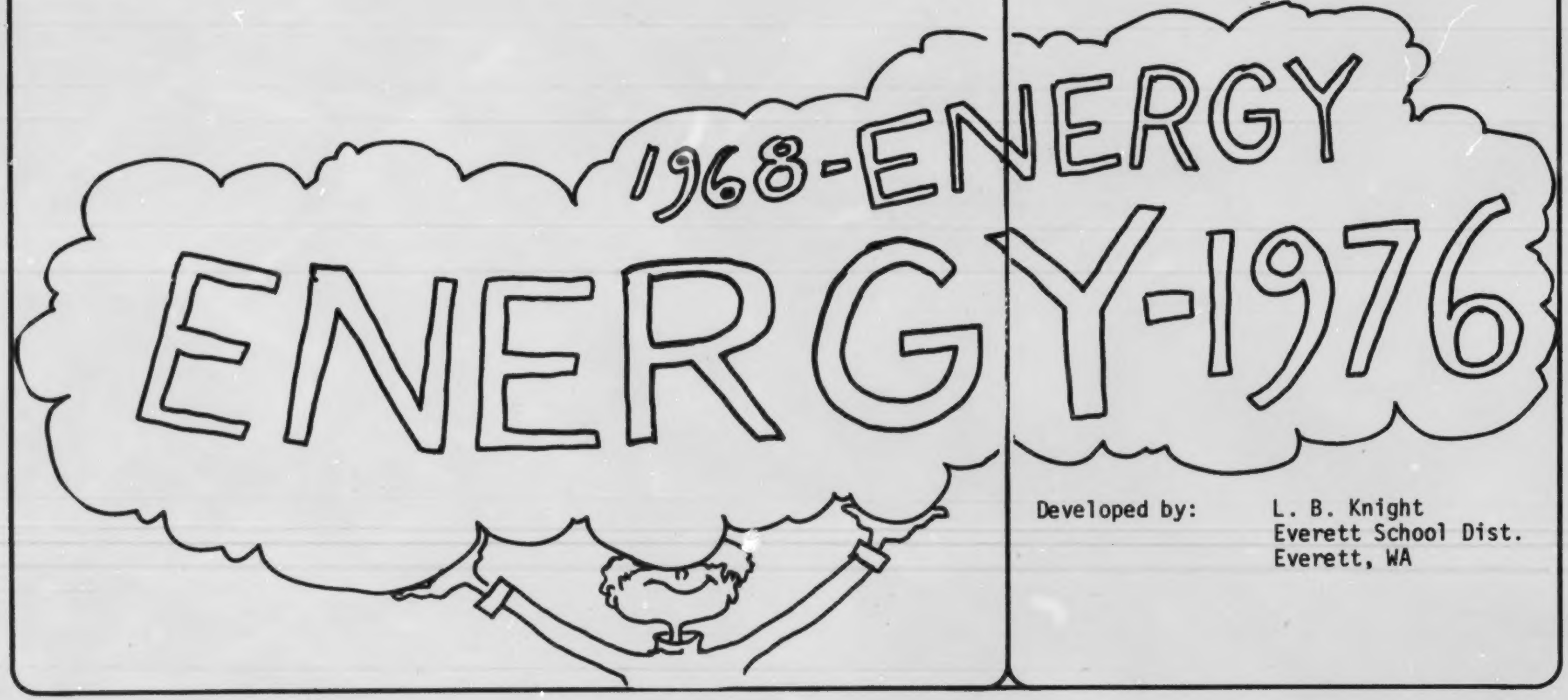
SUGGESTED CAREER EDUCATION ACTIVITY:

Given the opportunity to preview graphs from the Occupational Outlook Handbook showing the increase in numbers of jobs in different classifications of occupations, the student will be able to discuss the probable availability of employment in a variety of occupations in the future.

materials:

SUGGESTED ASSESSMENT ACTIVITY:

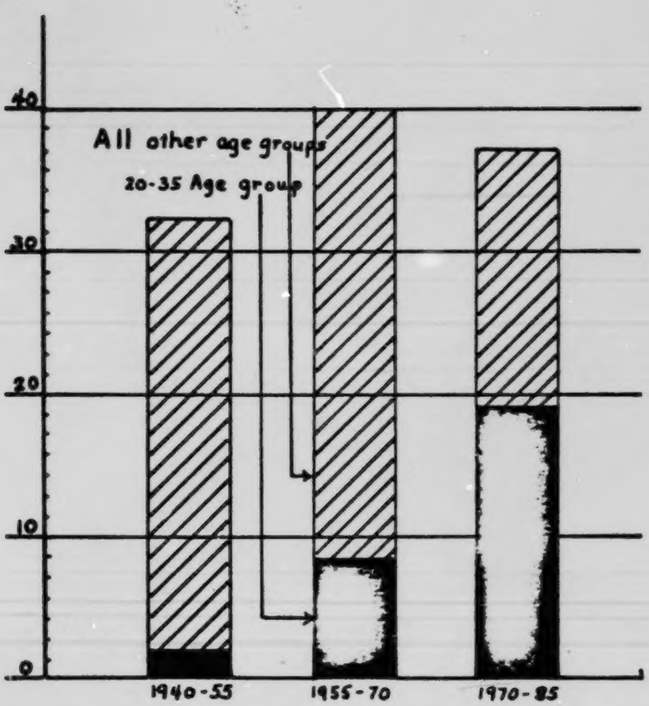
Given the opportunity to complete a variety of tasks, the student will be able to identify the significance of rapid population and energy growth and hypothesize about probable trade-offs.



Developed by: L. B. Knight
Everett School Dist.
Everett, WA

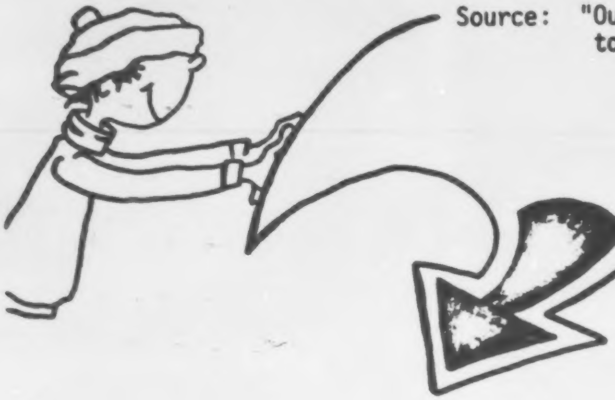
POPULATION GROWTH

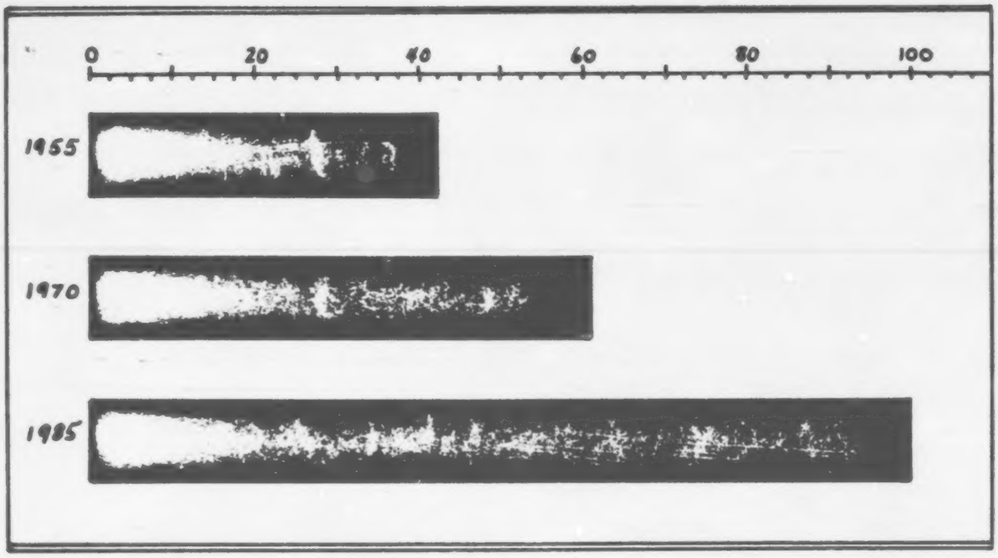
Source: "Outlook for Energy in the United States to 1985," The Chase Manhattan Bank, 1972



PER CAPITA USE OF ENERGY (barrels yearly - oil equivalent)

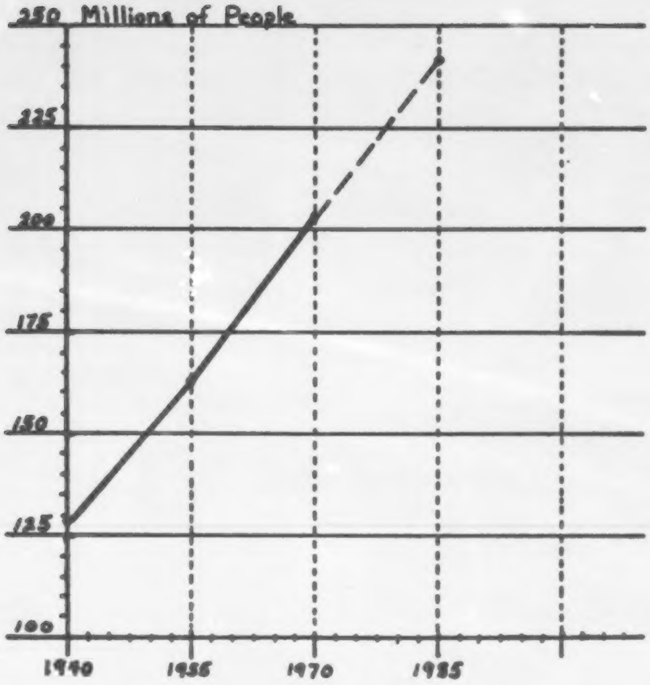
Source: "Outlook for Energy in the United States to 1985," The Chase Manhattan Bank, 1972

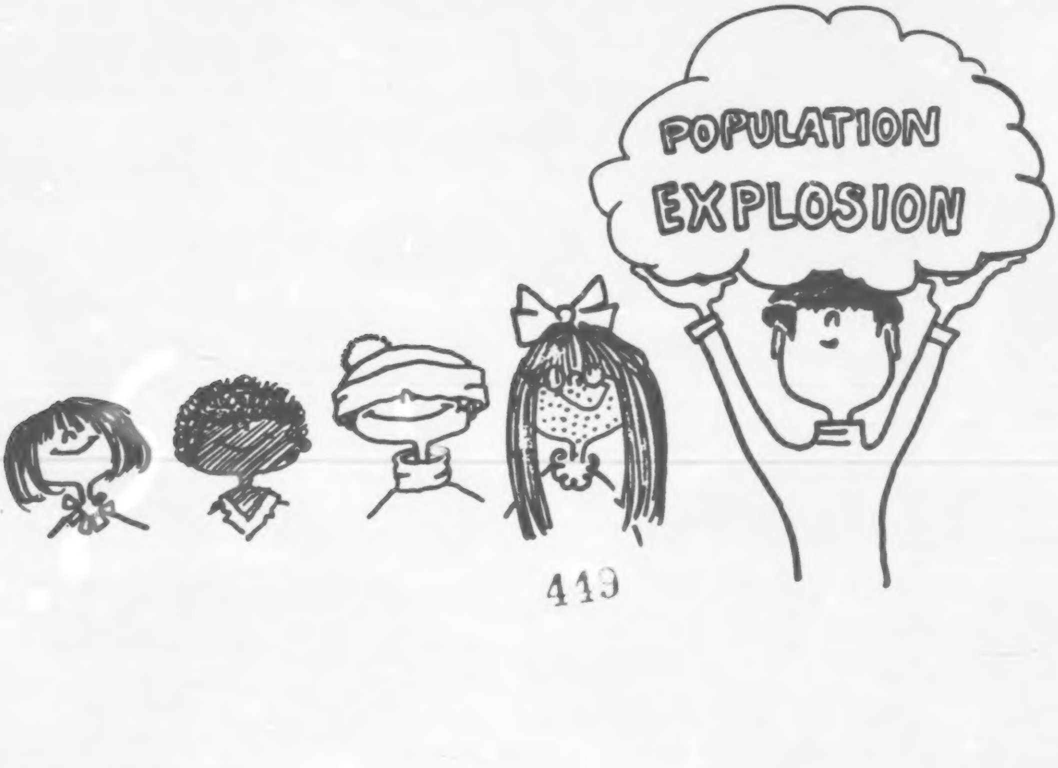




U.S. RESIDENT POPULATION

Source: "Outlook for Energy in the United States to 1985," the Chase Manhattan Bank, 1972





title: "Energy and The Economy"

future ?

concept: Future energy systems will require large amounts of economic capital.

objective: Given the opportunity to participate in a stockmarket activity, the student will be able to recognize how recent energy problems have affected our economy and to anticipate future effects of an energy shortage.

time: Variable

subject matter area: Social Science, Mathematics Consumer Education

grade: 10-12

implementation: Several possible variations exist as to the implementation of this activity. The intended use is as follows. Options will be discussed later.

Activity: 1. Day 1: Sometime prior to discussion of the energy dilemma and before any mention of it as an upcoming unit, students will discuss what a corporation is and how the stock market operates.

a. The instructor should explain that most large companies in America are corporations. A corporation can be defined as "a business organized under state law consisting of one or more owners (stockholders) and possessing the legal attributes of a person (the right to own property, pay taxes, sue, etc.)." The teacher might want to explain that while there are two other types of companies - single proprietorship and partnership - over 75 per cent of all business is done by corporations. It might also be explained that corporations are so popular because of three advantages:

materials:

Attached materials
Financial page of newspaper

activity no. 9

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implementation:

materials:

Activities:
(continued)

- Limited liability - Stockholders only lose their investment if the company goes bankrupt; their homes, cars, etc. cannot be sold to pay company debts.
- Legal permanence - When stockholders die, the corporation lives on; this is not true of the two other forms of ownership.
- The ability to accumulate larger sums of capital than the other two forms results from the sale of bonds, which only corporations can do.

Note: The above detailed explanations of a corporation would be essential if time were prohibitive.

b. A second term which would warrant definition is stock. A simple definition is "an official certificate indicating ownership in a corporation and the number of shares owned." The teacher should display some sample certificates if they are available and indicate that most large corporations have millions of shares in circulation. Thus, if Bob owns one share of Prudential Life Insurance, he does, indeed, "own a piece of the rock," but perhaps only 1/10,000,000th.

c. A third term which should be explained is a stock exchange. The financial page of a local newspaper should be explained. The class might be told that at times 20,000,000 shares of stock are bought and sold in one day on the largest exchange, the New York, representing billions of dollars. If a teacher wanted to spend the time, the actual process for buying stock through a broker and terms such as bull (up) and bear (down) markets might be explained. Copies of annual reports could also be distributed if time permitted. Again all of this is optional.

implementation:

Activities: (continued)

Now the actual exercise can begin; if all of the abovementioned options are included, this might have to begin Day 2.

2. Day 2: Each student should be told that he will be given a specific amount of money to invest. As a suggestion, the amount of money should be between $5,000 to $10,000 as this will allow several purchases and does not seem infeasible. The following is a list of steps to take:

   a. Each student should receive a copy of the "New York Stock Exchange Prices for Selected Stocks." The sheet with only one column of prices should be distributed. In all cases, these are the actual prices of the stocks as of February 1, 1973, September 1, 1973 and February 1, 1974. The students should not be so informed. Tell them that these are 23 of our nation's largest corporations representing several industries. They probably are familiar with all but A.M.F., Allis-Chalmers, Chase-Manhattan, North America Coal and Open Road.

   b. Next, distribute one of the "Financial Portfolio" sheets with spaces for ten stock purchases to each student.

   c. Have them purchase stock in a minimum of five and a maximum of ten companies. Let them round the price per share up or down as would be indicated by the fractional price. Tell them that they are to spend as close to the $10,000 as possible, but that they must not exceed that figure. If need be, allow them to complete the next day. I would advise against their being allowed to get information from parents, etc.

materials:

implementation:

Activities:
(continued)

d. As an inducement to insure that they seriously weigh the decisions involved, an inducement of a prize or an "A," etc. might be offered.

e. The portfolios and price sheets should now be collected and filed away. If a teacher so desired, simulated certificates could be given to the students.

3. Day 2 or 3: This day would not be the next calendar day. It would occur either during or at the conclusion of some discussion of energy problems. It would proceed as follows:

a. In a matter-of-fact way, tell the class that today you will go back to their initial stock investments of one week, month, etc., ago.

b. Give the students their original portfolios back. Two options exist here:
   - Without referring to an energy dilemma, allow them to switch stocks at the original price. In order to do this, you would give them a second portfolio sheet with fifteen possible purchases. After they have switched stocks, give them the second "New York Stock Exchange Closing Price Sheet." Have them add up the total value of their present portfolio. Ask them to notice for the entire sheet which stocks declined (significantly) in price; then ask them if they had anything in common. Eleven of them are all petroleum or travel-dependent companies; Allis-Chalmers, Chrysler, Dupont, G.M., Goodyear, Holiday Inn, Jantzen, Mobil Oil, Open Road, Pan Am, and Upjohn.
   - The class should not be told that an energy crisis did indeed occur between February 1, 1973, and September 1, 1973.

materials:

implementation:

Activities:
(continued)

- Have the class determine which industries benefited the most from the crisis. Note that A.M.F. and North America Coal were aided by a shift to bicycles and the use of coal rather than oil.
- Now distribute a third portfolio sheet, the one containing fifteen slots. Tell them to utilize their knowledge of the long-term nature of the energy dilemma and to adjust their portfolio accordingly. They should indicate sale and purchase of shares.
- The class could now be given the third price list of stocks with the third column indicating stock prices on February 1, 1974, at the height of the crisis. They should now determine the final value of their portfolio. From the original $10,000, how much profit or loss has occurred?
- The class should now discuss the long-term economic effects of the energy crisis and how this may affect our economic growth and their future individual investment decisions.

b. The second alternative is virtually identical to the first. The major difference is that students would simply be informed that an energy dilemma is occurring. They would then be presented with the second stock price sheet and told to determine the value of their original investment. They would be allowed to switch to different corporations with the remaining capital. Finally, the third price sheet would be distributed to determine if they utilized the knowledge gained in the last exchange. The discussion of the investment effects of the energy dilemma would remain the same.

materials:

implementation:

Activities: (continued)

4. A third and/or fourth day could be spent in reading and discussing an excellent article in the April, 1974, issue of Fortune magazine on the effects of the energy dilemma on certain industries.

5. One option available is to allow all of the investment decisions to be made in groups. While this would be more time consuming, the interchange of ideas and the valuable lessons learned in the art of compromising might be worth it.

SUGGESTED CAREER EDUCATION ACTIVITY:

Given the opportunity to discuss the role of the individual consumer in the total economy, the student will be able to list the effects upon employment opportunities which are created by sudden changes in economic activity and how these changes would be helpful in a students career preparation plans.

materials:

SUGGESTED ASSESSMENT ACTIVITY:

Given the opportunity to buy and sell stock, the student will be able to determine, through class activities and discussions, the effects of an energy crisis upon the economy.

Developed by: Elliott Cheap
Everett School District
Everett, WA

Revised by: Duane K. Altig

Financial Portfolio

Stockholder ______________________________

Name of Stock	Price per share	# of shares bought/sold	Value of Purchases/sales
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
13.			
14.			
15.			

Total Investment ________________

Date of Purchase ____________________

Stockholder's Signature ______________________________

N.Y. Stock Exchange Closing Prices for Selected Stocks

Corporation	Current Price
1. A.M.F. (Bicycles and other sporting goods)	36 3/8
2. Allis-Chalmers (Trucks)	10 1/2
3. A.L.C.O.A.	53 1/2
4. A.T. & T.	51 3/8
5. Chase-Manhattan Bank	57 3/8
6. Chrysler	36 1/8
7. Coca-Cola	143 1/2
8. Dupont Chemical	171 1/2
9. General Mills	63 1/2
10. General Motors	76 1/8
11. Goodyear Tire	27 3/8
12. Holiday Inn	34 7/8
13. I.B.M.	429 3/8
14. Jantzen	20 1/2
15. McDonalds	3 3/4
16. Mobil Oil	73 1/2
17. North American Coal Co.	22
18. Open Road Recreational Vehicles	31 1/2
. Pan Am Airlines	8 7/8
20. Sears	112 1/2
21. Shell Oil	54 5/8
22. U.S. Steel	30 5/8
23. UpJohn Pharmaceutical	117 3/4

N.Y. Stock Exchange Closing Prices for Selected Stocks

Corporation	Current Price	New Price	New Price
1. A.M.F. (Bicycles and other sporting goods)	36 3/8	28 1/2	48 1/2
2. Allis-Chalmers	10 1/2	11 7/8	9 1/8
3. A.L.C.O.A.	53 1/4	72 1/2	70 1/4
4. A.T. & T.	51 3/8	47 1/2	50 7/8
5. Chase-Manhattan Bank	57 3/8	49	53 1/8
6. Chrysler	36 1/8	33	16 1/8
7. Coca-Cola	143 1/2	140 7/8	117 1/8
8. Dupont Chemical	171 1/2	160 1/2	158 7/8
9. General Mills	63 1/4	57 1/2	58
10. General Motors	76 1/8	64	50 7/8
11. Goodyear Tire	27 3/8	22 1/4	16 1/8
12. Holiday Inn	34 7/8	22 1/4	14 1/2
13. I.B.M.	429 3/8	301	271
14. Jantzen	20 1/2	17 7/8	12 1/8
15. MacDonald's	3 3/4	3 1/2	3
16. Mobil Oil	73 1/2	59	48 1/8
17. North American Coal Co.	22	20 1/2	36 7/8
18. Open Road Recreational Vehicles	31 1/2	22 1/2	10 1/2
19. Pan Am. Airlines	8 7/8	5 1/8	3 7/8
20. Sears	112 1/2	96 1/4	87
21. Shell Oil	54 5/8	53 1/2	56 1/8
22. U.S. Steel	30 5/8	29 3/8	39 1/2
23. Upjohn Pharmaceutical	118 3/4	86 1/2	62 7/8

N.Y. Stock Exchange Closing Prices for Selected Stocks

Corporation	Current Price	New Price
1. A.M.F. (Bicycles and other sporting goods)	36 3/8	38 1/2
2. Allis-Chalmers (Trucks)	10 1/2	11 7/8
3. A.L.C.O.A.	53 1/2	72 1/2
4. A.T. & T.	51 3/8	47 1/2
5. Chase-Manhattan Bank	57 3/8	49
6. Chrysler	36 1/8	33
7. Coca-Cola	143 1/2	140 7/8
8. Dupont Chemical	171 1/2	160 1/2
9. General Mills	63 1/2	57 1/2
10. General Motors	76 1/8	64
11. Goodyear Tire	27 3/8	22 1/4
12. Holiday Inn	34 7/8	22 1/4
13. I.B.M.	429 3/8	301
14. Jantzen	20 1/2	17 7/8
15. McDonald's	3 3/4	3 1/2
16. Mobil Oil	73 1/2	59
17. North American Coal Co.	22	20 1/2
18. Open Road Recreational Vehicles	31 1/2	22 1/2
19. Pan Am Airlines	8 7/8	5 1/8
20. Sears	112 1/2	96 1/4
21. Shell Oil	54 5/8	53 1/2
22. U.S. Steel	30 5/8	29 3/8
23. Upjohn Pharmaceutical	117 3/4	86 1/2

title: "The Energy Intensive Society - What It Is Not "

future ?

concept: Energy policy decisions will affect the availability and distribution of energy in the future.

objective: Given the opportunity to compare two types of societies, the student will be able to demonstrate his knowledge and understanding of the part energy plays in a developed society.

time: 4 - 45 minute class periods

subject matter area: Social Science, Language Arts

grade: 10-12

implementation:

Activity: 1. The energy intensive society - What it is not. (30 minutes) (Skills: Observation, compare and contrast, inference.)

a. Show class a picture of a large construction project in a labor-intensive society (e.g., China or India).

b. Show class a picture of the same type of building activity in an energy intensive society.

c. Using good observation techniques, what inferences can the student make from the data the pictures supply? Who are the people shown? What are they doing? What country is this? When was the picture taken? Season? Time of day? How are they achieving their purposes? Why are they doing it this way? Why might the one country prefer to use hand labor for such tasks? How do time investment factors compare?

d. What things do these two pictures have in common (compare them)? Common purpose (e.g., to build a dam or plant a crop). Common materials, concrete, stone, steel, etc.

materials:

Picture of hand labor in labor-intensive society engaged in some specific project (farming, road building, dam construction, etc.).

Picture of machines doing similar work in energy-intensive society.

A series of pictures of life in an energy-intensive society.

Note: Pictures can be slides, hand-passes, projected with opaque projector or on a filmstrip.

activity no. 10

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implementation:

Activities:
(continued)

e. What things are different in these two pictures? Use of machines vs. hand labor. Some materials or techniques different (e.g., use of crude scaffolds to reach high places, simple baskets to move earth, etc.)

f. Student lists his answers in his personal notes. At end of observation time, answers are compared and teacher makes a master list. Students amend theirs to suit.

2. The energy-intensive society - What it is. (30 minutes) (Skills: Categorizing, note taking, observing.)

a. Show class a series of pictures of life in developed societies.

b. Student observes carefully and makes three lists under these headings:
  - Energy being used (e.g., muscles, gasoline, electricity, burning wood, diesel, coal, etc.).
  - Energy being stored for use (e.g., gas in tanks, wood in piles or trees, water behind a dam, coal in a bin, etc.).
  - Energy invested in an object (e.g., natural gas to fire bricks or produce fertilizer, coal to produce steel, energy for producing cement, electricity to manufacture aluminum, etc.).

3. The uses and affects of energy - Value choices. (2 hours +)

materials:

Interim quizzes over each sub-unit:
Five or ten representative questions to evaluate each of the student activities.

Example 1: In an energy-intensive society, most physical chores are done by machine. To demonstrate awareness of this fact, list ten tasks performed by machines in an energy-intensive society that are done with animal energy in a labor-intensive society (e.g., water is pumped, stored and distributed with electric pumps).

Example 2: Essay answer. Respond to this statement "An energy-intensive society makes better use of its resources than a labor-intensive society. They extract the potential energy from stored water, from buried minerals, from growing trees, from the sun, the winds, the tide. Unused, these potential power sources are simply wasted."

Note: Write two answers - one as though you were an environmentalist and one as though you were an industrialist.

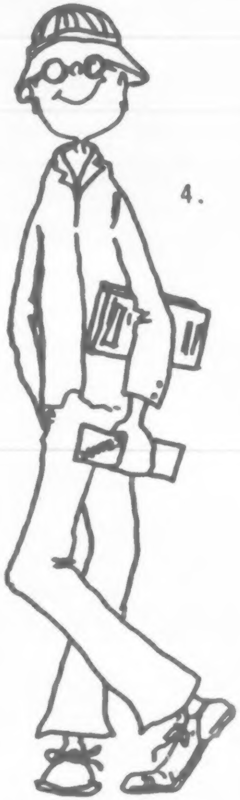
Example 3: Demonstrate your understanding of the difference between labor-intensive and energy-intensive societies by labeling each of the following statements with an "E" if it is characteristic of an energy-intensive society and with an "L" if it is characteristic of a labor-intensive society.

implementation:

Activities:
(continued)

a. The class takes a walk that includes an industrial area, a business section, a residential area and, if possible, a rural area.

b. Students observe and record:
- Specific beneficial uses of energy (e.g., to move heavy loads, to illuminate dark areas, to power emergency vehicles, etc.).
- Specific negative effects of energy use (e.g., pollution, visual, air, water, etc., land use, lack of exercise for energy-dependent people, etc.).



4. Life without energy - Value choices. (60 minutes)
(Skills: Observation.)

a. Student views a film showing life in a society that uses only the simplest forms of energy (e.g., a film about hunting-food gatherers in the desert or hunters in the arctic, etc.).

b. Student observes and lists:
- Advantages of life in such a society (e.g., a slower pace, time for friends, simple pleasures, clean air, water, etc.
- Disadvantages of this life (e.g., animal energy main source of power, much time invested getting the necessities of life, few of life's luxuries (e.g., toasters, televisions, freezers, etc.).

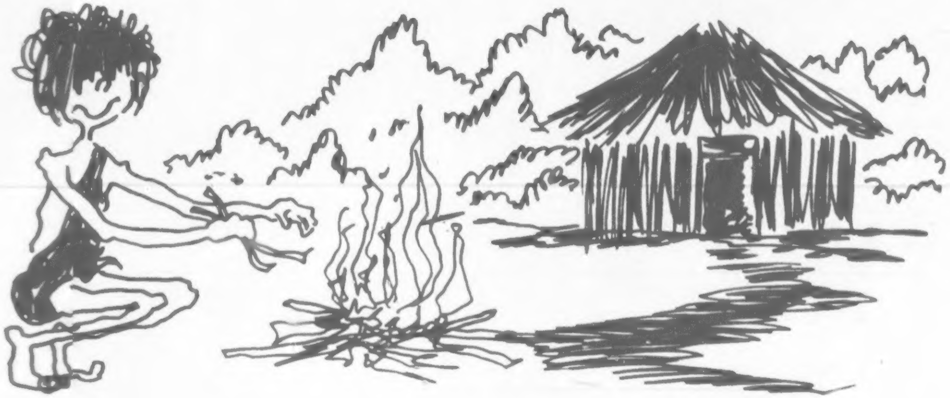
materials:

____1. Thousands of poles with miles of wires strung from point to point.
____2. Most of life's activities take place from dawn to dusk.
____3. Roads are narrow and unimproved.
____4. Appointment times are very casual and promptness and punctuality are not the rule.
____5. People pay to observe other people exercise or play games.
____6. "Fads" or fashions in clothes, home furnishings and other possessions are common.
____7. Consumer goods (for purchase) are limited in variety and availability.
____8. Daily lives of most adults do not provide the exercise needed to maintain a healthy human being.
____9. Cultural opportunities are richly available.
____10. People generally live close to their daily work.

implementation:

SUGGESTED CAREER EDUCATION ACTIVITY:

Given an opportunity to compare pictures of labor activities in primitive and modern societies, the students will be able to recognize the technological changes which have occurred, and identify the areas where retraining was necessary.



materials:

SUGGESTED ASSESSMENT ACTIVITY:

Given the opportunity to complete a series of related activities and quizzes, the student will be able to cite several advantages energy affords society, and several disadvantages of energy in an energy-intensive society.

Developed by:	L. B. Knight Everett School District Everett, WA

title: "Decisions - Decisions"

future ?

concept: Energy policy decisions will affect the availability and distribution of energy in the future.

objective: Given the opportunity to gather the necessary data, the student will be able to identify the laws, etc. which relate to the role of the individual in energy decisions.

time: Variable

subject matter area: Social Science

grade: 10-12

implementation:

Activity:

1. Divide the class into small groups, and assign each of the groups one of the following topics:
   a. City (local) government
   b. County government
   c. State government
   d. Federal government
2. Have each group research the laws, ordinances, policies, etc. related to energy and/or pollution. Collect information relative to:
   a. Dates
   b. Major provisions
   c. Regulations, Fines, Fees, etc.
   d. Other pertinent information
3. Construct a large bulletin board and list by title each of the items identified by each group
4. Each group will present their findings to the class.
5. The class will discuss the laws, etc. as they relate to the individual's role in their implementation and the influence these laws, etc. have upon the individual's present and future decisions.

materials:

SUGGESTED ASSESSMENT PROCEDURE:

Given the opportunity to work in small groups, the student will be able to identify laws, etc. which relate to the role of the individual in energy decisions.

Developed by: Duane K. Altig
Parkrose School Dist.
Portland, OR

activity no. 11

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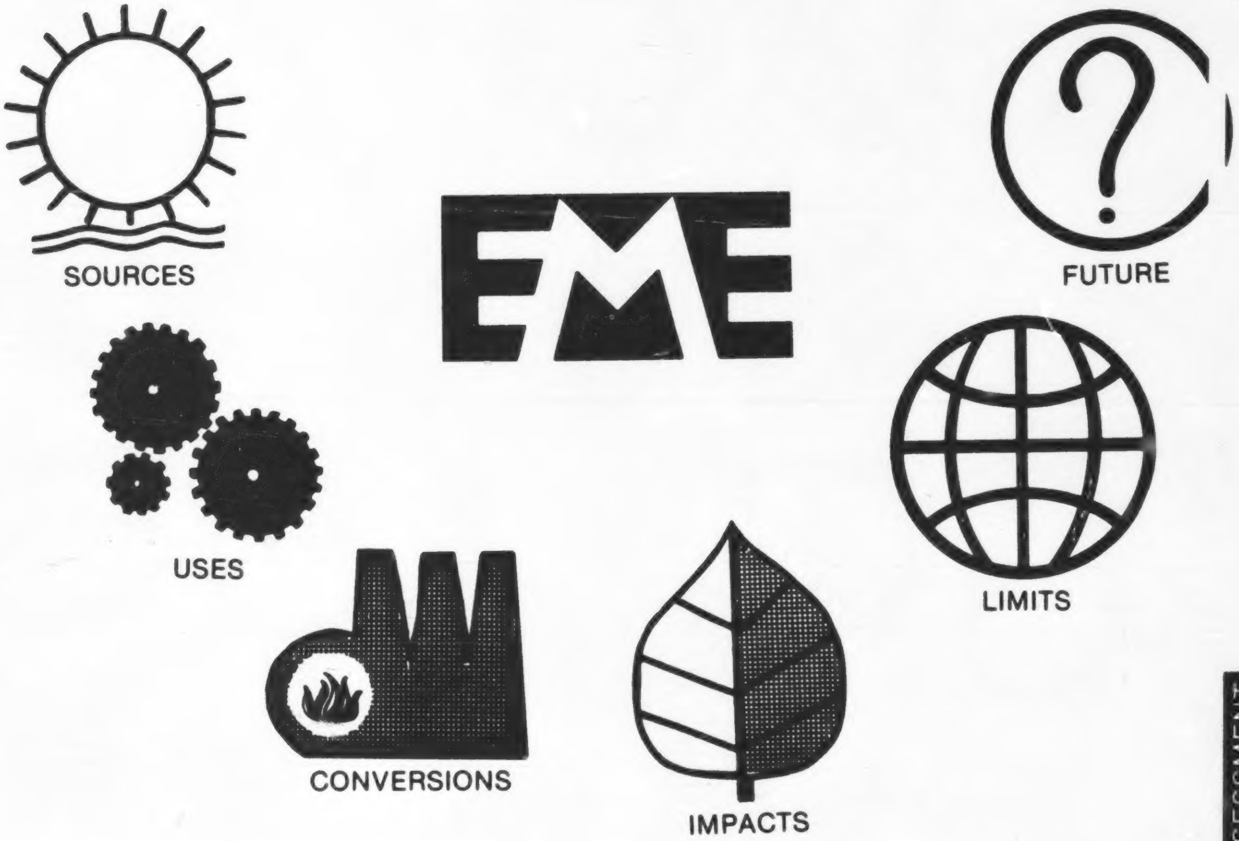
STUDENT ASSESSMENT

ENERGY AND CONSERVATION EDUCATION

Activities for the Classroom

Grades 10-12



ASSESSMENT

STUDENT ASSESSMENT

Using The Suggested Test Items

The following test items are examples only and are not intended to be the final assessment for the entire notebook. The instructor may wish to select questions from this list to judge the preparedness of the students or to use as a nucleus for a final test covering all areas of the notebook.

Origin Of Test Items

Each test item is derived from a corresponding learning activity. For example, a suggested test item has been prepared from Sources, Activity #1. A test item has been suggested for each activity.

Type Of Suggested Test Items

Most of the test items are multiple choice, true or false, completion, "fill in the blank," or class discussion questions. For the convenience of the teacher, a "key" has been prepared, giving the answer to each question.

SUGGESTED TEST ITEMS
(10-12)

SOURCES:

Activity #1	1.	List at least five (5) steps in the processing of food you eat and identify the sources of energy required for each.
Activity #2	2.	Suggest one means for providing shelter, and suggest a means for reducing energy costs.
Activity #3	3.	List three (3) factors which cause an energy source or conversion to be expensive, and three (3) factors that will lower the costs.
Activity #4	4.	Select an energy source and diagram its installation.
Activity #5	5.	Write descriptive paragraphs of the training needs for three(3) occupations related to an energy source of your choice.
Activity #6	6.	Select one article of clothing and identify all the occupations in its production.
Activity #7	7.	Select a conflict related to the use or source of energy and resources, and discuss how cultural patterns may result from the solution of the conflict.

SUGGESTED TEST ITEMS
(10-12)

USES:

Activity #1 1. List five causes of inadequate nutritious food supplies for the world's population.

Activity #2 2. A means of producing hydrogen fuel is
a. - electrolysis.
b. - electrification.
c. - hydrolysis.
d. - None of the above.

Activity #3 3. To calculate the flow rate of a stream, use the formula Distance = Velocity x ________.

Activity #4 4. Select an item of aesthetic appeal and describe the energy input for the selected item.

Activity #5 5. True/False: It is possible to develop a questionnaire that will indicate if a person is a high energy user or a low energy user.

Activity #6 6. Discuss the factors that determine which energy source should be used in space heating.

Activity #7 7. The result of pollution reduction on local or regional electrical energy production would be
a. - an increase in electrical energy use.
b. - a decrease in electrical energy use.
c. - no change in electrical energy use.
d. - None of the above.

Activity #8 8. Which fuel is increasing in popularity in the West?
a. - Oil
b. - Gas.
c. - Electricity.
d. - None of the above.

Activity #9 9. The food energy consumed is increasing and the energy input to the food system is
a. - increasing at the same rate.
b. - increasing at a faster rate.
c. - decreasing.
d. - None of the above.

SUGGESTED TEST ITEMS
(10-12)

USES:

Activity #10 10. Which of the following would reduce home energy consumption?
- a. - Insulation.
- b. - Double-paned windows.
- c. - Both a and b.
- d. - None of the above.

Activity #11 11. True/False: Energy decisions influence the standard of living.

Activity #12 12. List ten (10) ways to conserve energy in your own leisure time activities.

SUGGESTED TEST ITEMS
(10-12)

CONVERSIONS:

Activity #1 1. True/False: It would be possible to use the thermal energy in the sea water of the Arctic for running a heat engine.

Activity #2 2. The equation for the energy budget of any organism is
a. - output = input + stored growth.
b. - input = output + stored growth.
c. - output = input - stored growth.
d. - None of the above.

Activity #3 3. True/False: The waste products from artificial energy conversion systems are more difficult for the natural environment to accommodate than waste from natural energy conversion systems.

Activity #4 4. Heat can be transferred from one place to another by
a. - molecular motion.
b. - thermometers.
c. - evaporation.
d. - None of the above.

Activity #5 5. The formula for maximium efficiency is:
a. - $\frac{T_1-T_2}{T_3} \times 10 = \% \, {}^{E}\mathrm{max}.$
b. - $\frac{T_1-T_2}{T_1} \times 100 = \% \, {}^{E}\mathrm{max}.$
c. - $\frac{T_1-T_2}{T_2} \times 100 = \% \, {}^{E}\mathrm{max}.$
d. None of the above.

Activity #6 6. Discuss the problems related to the development of a new law to deal with a selected energy problem.

Activity #7 7. Describe the effects of an introduction of the technology of energy conversion into a primitive society.

Activity #8 8. Discuss the implications of the changes in energy technology required to move from one form of transportation to another.

SUGGESTED TEST ITEMS

(10-12)

IMPACTS:

Activity #1 1. Preparation of an environmental evaluation matrix can predict the ________________ of a geothermal site.

Activity #2 2. Describe the type of shopping center which best benefits your own local community.

Activity #3 3. Select the type of power plant you would prefer to have built near your home and support your selection.

Activity #4 4. Which of the following has not had a negative impact on the environment?
a. - Freeways.
b. - Autos.
c. - Mass transit.
d. - None of the above.

Activity #5 5. List ten (10) good and bad uses of energy using activities.

Activity #6 6. True/False: Unwise energy uses are easily identified.

Activity #7 7. Discuss the reaction of one of the following to the location of a nuclear power plant; banker, housewife, realtor, industrialist.

Activity #8 8. Describe the lifestyle that will follow from a tougher, more closely regulated energy-use program.

Activity #9 9. Which of the following is not a factor in the siting process for an energy plant?
a. - Environmental.
b. - Institutional.
c. - Economic.
d. - None of the above.

Activity #10 10. Discuss the issues involved in meeting our energy needs and protecting the environment as expressed in the Alaskan pipeline controversy.

Activity #11 11. How will the traditional values of individualism, privacy, and free enterprise be influenced by changes in the energy policies.

SUGGESTED TEST ITEMS
(10-12) Continued

IMPACTS:

Activity #12 12. How do special interest groups influence the regulation of energy producers and users?

Activity #13 13. The least expensive method of mining coal is
a. - open pit.
b. - strip.
c. - shaft.
d. - None of the above.

Activity #14 14. Describe the process involved in the production of a natural pollutant or contaminant.

Activity #15 15. The average amount of garbage per person each day in the United States is
a. - 2.27 Kg
b. - 4.6 Kg
c. - one ton.
d. - None of the above.

Activity #16 16. Select an occupational career in the area of environmental science and describe how a community could use the services of the selected occupation.

SUGGESTED TEST ITEMS

(10-12)

LIMITS:

Activity #1	1. Which of the following resources is finite? a. - Oil. b. - Coal. c. - Both a and b. d. - None of the above.
Activity #2	2. Discuss the potential impact to the economy of the present consumption rate of a finite source.
Activity #3	3. Discuss the following: As world populations increase and higher standards of living develop, it becomes vital to practice conservation of natural resources.
Activity #4	4. Which of the following is "limited"? a. - Water. b. - Air. c. - Both a and b. d. - None of the above.
Activity #5	5. Discuss the dilemma of energy demand and the fossil fuel reserves.
Activity #6	6. Select an item and show or discuss the energy that goes into the production of the item.
Activity #7	8. One of the problems of utilities is a. - increasing costs. b. - decreasing costs. c. - stablizing costs. d. - None of the above.
Activity #8	9. Discuss this statement: "What role did coal play in the development of the United States?"

SUGGESTED TEST ITEMS
(10-12)

FUTURE:

Activity #1 1. Geothermal energy was first produced in
- a. - Italy.
- b. - United States.
- c. - Iceland.
- d. - None of the above.

Activity #2 2. True/False: The laser is an instrument to amplify and sharpen relatively weak waves of light to produce a very narrow, powerful beam.

Activity #3 3. Discuss the question: "Is hydrogen the way out of the energy crisis?"

Activity #4 4. Estimates of geothermal power generation are predicted to be this percent of the overall United States energy consumption by the year 2000.
- a. - 0.1%.
- b. - 0.2%.
- c. - 1.5%.
- d. - None of the above.

Activity #5 5. Give an example of a current use of solar energy.

Activity #6 6. Which of the following states has more nuclear plants than the one listed?
- a. - Alabama.
- b. - Illinois.
- c. - Utah.
- d. - None of the above.

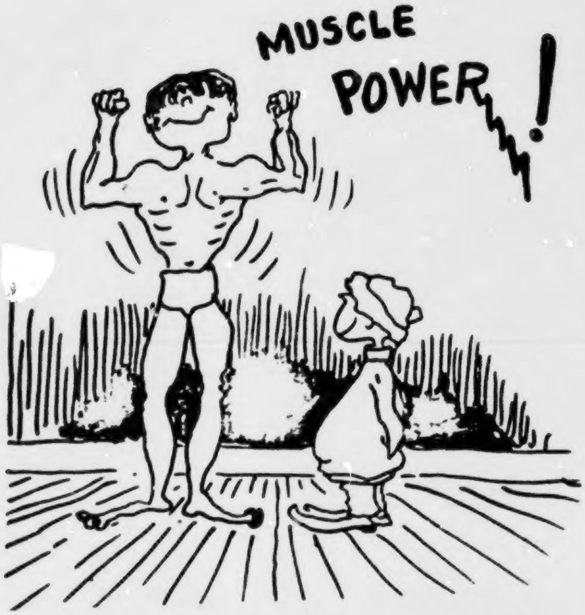
Activity #7 7. Fusion must take place at an extremely high ________________.

Activity #8 8. An alternative to the energy supply pool being increased at a much greater rate than the population growth rate is
- a. - an increase in population.
- b. - a change in lifestyle.
- c. - a decrease in population.
- d. - None of the above.

SUGGESTED TEST ITEMS
(10-12) Continued

FUTURE:

Activity #9	9.	Discuss the effect of an energy crisis upon the economy.
Activity #10	10.	Give examples of advantages energy affords society and disadvantages of energy in an energy intensive society.
Activity #11	11.	Give at least three (3) examples of laws, regulations, etc. which relate to the role of the individual in energy decisions.



SUGGESTED TEST ITEMS
TEACHER'S ANSWER KEY

SOURCES

1. answers will vary
2. answers will vary
3. answers will vary
4. answers will vary
5. answers will vary
6. answers will vary
7. answers will vary

USES

1. answers will vary
2. a
3. Time
4. answers will vary
5. True
6. answers will vary
7. a
8. b
9. b
10. c
11. True
12. answers will vary

FUTURE

1. a
2. True
3. answers will vary
4. c
5. solar energy is used in 90% of unmanned space craft
6. b
7. temperature
8. b
9. answers will vary
10. answers will vary
11. answers will vary

IMPACTS

1. environmental impact
2. answers will vary
3. answers will vary
4. d
5. answers will vary
6. True
7. answers will vary
8. answers will vary
9. None of the above
10. answers will vary
11. answers will vary
12. answers will vary
13. a
14. answers will vary
15. a
16. answers will vary

LIMITS

1. c
2. answers will vary
3. answers will vary
4. c
5. answers will vary
6. answers will vary
7. c
8. answers will vary

CONVERSION

1. True
2. b
3. True
4. a
5. b
6. answers will vary
7. answers will vary
8. answers will vary